Madras Agricultural Journal

[ORGAN OF THE M. A. S. UNION]

Vol. XX] MAY 1932 [No. 5

CONTENTS

THE PHYSIOLOGY OF TILLERING IN THE PADDY PLANT

By C. V. SARVAYYA, B. Sc (A.g).

Paddy Assistant. Agricultural Research Station, Maruter.

1. Introduction. Paddy, being the chief food crop of the presidency, received a great amount of attention in the economic improvement of its race, by selection, hybridisation and by variation in cultural practices to the best advantages, such as thin sowing, wide planting, and different processes of manuring. During the course of study for selection, though many strong correlations between sets of characters were met with, e g.,

1. Scanty tillering and bunched head,
2. Bunched head with fine grains and sterility,
3. Colour of glume and setting,

and 4. Setting and shedding

their relationship with the various physiological functions of the plant were not fully known, and they had to be taken as empirical features of a particular variety.

Besides these sets of intricate characters, the paddy plant cannot probably be viewed as an individual but as a colony of individuals—tillers—with different inter-relationships among one another at different times. The importance of tillering was recognised long ago, and it dates as far back as Jethro Tull, who explained the meaning of the word "To tiller is to branch out into many stalks and is the country

word that signifies the same as *fruiticare.*" It is not perfectly known, for example, whether a 3-tillered plant is going to be better than a 7-tillered plant in the long run, but so far as it can be surmised the number of tillers a plant develops forms an index of the compensative nature or character of the plant itself. But the subject of development of the several tillers of paddy plant has been analysed into the following broad features :

(a) Circumstances which influence tillering,
(b) Inter-varietal difference in respect of tillering,
(c) Morphology and physiology of tillering,
and (d) Various aspects of the relation between yield and tillering.

Though many of the aspects are common for all cereals and produce similar results, the physiology of tillering may be different in different cereals; and will go direct to the subject "Physiology of tillering."

II. Physiology of tillering. Harlan[1] was one of the early plant breeders who had interested himself in early growth characteristics of barley, and it is he who showed that in the time and manner of the formation of the first tiller, varieties exhibit appreciable differences. The extensive work of Engeldow[2] and his associates, Wadham[3], Ramaiah[4] and others have thrown much light on the varietal differences in the nature and order of tillering and the spatial effect on tillering with reference to the critical period in the development of tillers of the barley and wheat varieties. They have clearly shown that early tillering is an important index to yield, the exact details of its chronology constituting a definite varietal character.

Whether one tiller can profit by the activities of another has not yet been determined, for, the transference of photo synthetic material or root absorption products from one tiller to another in the graminaceous plant remains unknown except in sugarcane where the different tillers are said to be inter-dependant. Consequently, it is impossible to say whether late tillers which fail to form an ear or form at best very puny earheads are in relation to yield a help or a hindrance. If their products are translocated to the earbearing tillers they are naturally an asset. If not they compete for the salts and water of the soil, and their contribution to the harvest is straw only. Some of the probabale causes of variation in the tillers and tiller production of a plant will however be:

i. age of the plant at which the tillers are produced,

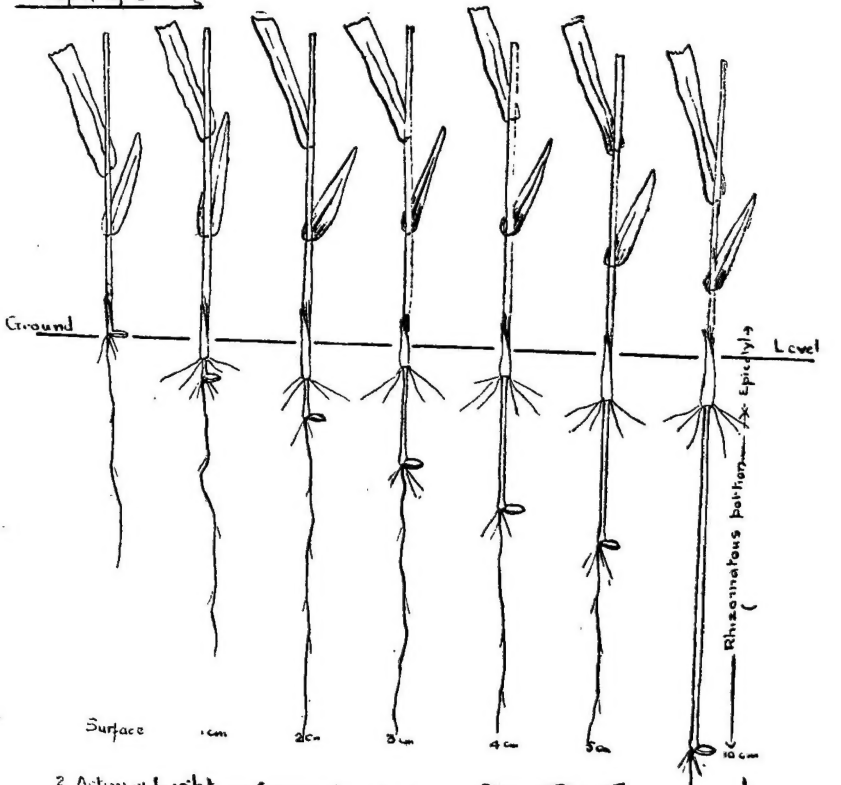
ii. time and conditions prevailing during the development of the several tillers,

and iii. the soil differences caused by the absorption of plant food by the earlier formed tillers, thereby leaving a different set of soil conditions for the later formed tillers. So a variety that finishes its tillering

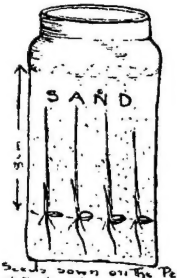
PLATE I

Tillering and Light perception of the Paddy Plant

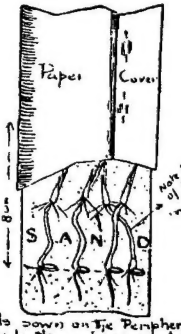
Depth of Sowing



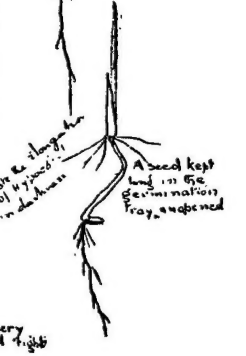
2 Action of Light on Germinating Seed



Seeds sown on the Periphery of the bottle and Exposed to Light



Seeds sown on the Periphery of the bottle and wrapped tight by a paper cover



phase in a short and more compressed period is likely to have uniform grain production per tiller and fare better than other varieties which tiller gradually and slowly. It is here that the customary appeal to 'soil differences' must almost reach its limits of application.

So from all this, it is clear that no positive proof of the behaviour of one tiller towards another can be easily had, and that proofs must be gathered gradually by circumstantial evidences.

(a) *Development of the primary stem.* The primary stem of a cereal embryo is extremely short and consists of hypocotyl or portion below the point of insertion of the scutellum and the epicotyl or the axis of the plumule.

When growth commences in grains sown in the ordinary way (broadcasted) in the field, the hypocotyl remains short, but the lower part of the hypocotyl lengthens into a thin erect rhizome, which pushes the terminal bud upwards through the soil. The length of the rhizomatous portion depends upon the depth of sowing.

The depth at which tillering or shooting begins, that is the point at which the plumule is arrested in its upward growth through the soil, is regulated chiefly by the light perception of the plant and by the depth at which the grain is sown. Paddy seed was sown at different depths, and the following data reveals some interesting facts about the behaviour of hypocotyl and epicotyl:

Table 1.

Depth of sowing.	Length of rhizomatous portion. cm.	Length of epicotyl. cm.	Date on which germs are seen above ground.	Remarks.
Surface.	...	1·0	13th April.	
1 cm.	0·5	1·3	13 ,,	
2 ,,	1·0	1·8	14 ,,	Dry seed sown on 11—4—31.
3 ,,	2·4	0·95	16 ,,	
4 ,,	3·3	1·1	16 ,,	
5 ,,	3·8	1·3	18 ,,	
7 ,,	5·8	1·4	25 ,,	
10 ,,	8·9	1·5	5th May.	

The fact that the hypocotyl grows a bit short of the ground level—fairly a constant length (1·3 cm.)—reflects in a way on a sort of subconscious state of intelligence of the plant regarding the perception of light. (Plate I).

To prove this directly, seeds were sown on the outer surface of a bottle, thereby facilitating penetration of light to the developing embryo. In this case the seedlings produced are just of the same nature as those sown on the surface, even though the peripheral sowing was at a depth of 8 c. m. from the top level of soil in the bottle. As the axillary buds commence only from the point of insertion of the

scutellum, all the above evidences go to show that tillering is a phenomenon closely connected with the powers of light perception of the cereal plant.

In shady or in over-crowded situations the tillering node is found nearer the surface than in sunny open ground, and it was found that a continuance of dull weather after late sowing tends to shallow tillering in wheat. (4).

(*b*). *The fate of the primary stem under transplanted conditions*— When a seedling is transplanted the old roots from the nursery die away and fresh roots are produced. Though we find that fresh roots are produced within 3 or 4 days after transplanting, we do not find that the crop has established by any change of foliage colourations from the yellowish green to dark green. But, on the other hand, the seedling grows paler till for about a week to ten days, when it gradually changes into the dark green colour of an established crop. This primarily shows that the initial roots formed are not engaged in the *nutrition* of the seedling but probably in the "*Water-supply*" to the seedling. This may be due to the lower osmotic pressure of cell sap of the new roots formed at that stage, as they are produced only from a seedling, whose activities have been temporarily kept in abeyance. It will be invariably found that when a crop of transplanted seedlings have established, a tiller on an average is produced by each plant. This tiller is found to develop roots first and obtain nutrition from the soil as is evidenced by the greenness of the crop. To suppose that the roots of this tiller are nutrition-absorbing ones is correct, as the crop turns green only when these roots begin to function. The first tiller to start with was produced as a parasite on the original seedling planted for the axillary bud is stimulated into a tiller before the original seedling got established and turned green. The parasitism seems to be only till the first developed tiller produces roots at its base. The absorbing power of the organs of such a parasitic tiller being by analogy higher, the efficiency of the roots of this tiller seems to be higher enough (higher than that of the roots freshly produced by the original seedling after transplantation) to absorb plant foods and feed the original seedling and the daughter tiller as well, in such a short time that the crop revives soon after the root production of this tiller.

The work of Venkatraman and Thomas[5] in Sugarcane has shown definitely that the 'Sett Roots' (comparable to the roots produced by the original seedling in paddy) are only of a temporary nature and cannot maintain the sugarcane plant all through and that the 'Shoot root' (comparable to the roots produced by the daughter tillers) are more vigorous in the intake of nutrients and serve as active organs in the quick build of the plant. The work of Wiggans and Jackson go to separately identify the two root systems as "Seminal" or "Temporary Roots" and "Nodal" roots.

(c). *The case of the manured seedling.* In this connection the case of the highly manured seedling warrants some consideration. It is but an every day experience that seedlings poor in the seedbed, when transplanted revive very well quickly and withstand even an unfavourable condition than seedlings highly manured. This may be due to the fact that the highly manured seedling being initially overcharged with potential energy cannot so easily and quickly admit of the development of a parasitic daughter tiller in the first place as the cell tension or osmotic power of the tiller must be higher still. So the daughter tillers develop only later when the host (or the parent seedling) is made to starve for a bit longer time and thus spend away its energy to some extent, before the daughter tiller develops on it. As soon as daughter tillers begin to develop, the fact that such highly manured seedlings begin to tiller profusely after taking a long time to establish, suggests three possible sources of solution (1) it is likely that the nutrition from the surcharged parent shoot passes on to the daughter tillers, (2) or the parent shoot being well equipped does not take much contribution from the daughter tillers (3) or the tension of the daughter tillers of a highly manured seedling is more than that of the daughter tillers of an ordinary seedling. The last of the suggestions seems to be more suitable as the vigour of the resulting shoot (made up of daughter tillers) happens to be felt for a long period in spite of even unfavourable conditions. Thus the highly manured seedling, though it does not contain proportionately ** more of plant food material, seems to be well charged with potential energy, which naturally exhibiting some high initial resistance, results finally in the useful discharge of the stored up potential energy for the better fitting up of the plant for high yield.

Magistad O. C. and Trong E. working on the influence of fertilisers in protecting corn against freezing have found out that the application of fertilisers increases the osmotic pressure of the sap, and the higher the osmotic pressure the greater the resistance.

Table 2. **Analysis of seedlings manured with different quantities of Chilean Nitrate on a basal dressing of 30 cartloads of cattle manure per acre.

Percentage of **	Normal	Chilean nitrate 80 lbs. per acre.	Chilean Nitrate 160 lbs. per acre
Nitrogen.	1·10	1·15	1·26
Phosphoric acid.	0·38	0·41	0·43
Potash.	1·99	2·28	2·00

** percentage of moisture free basis.

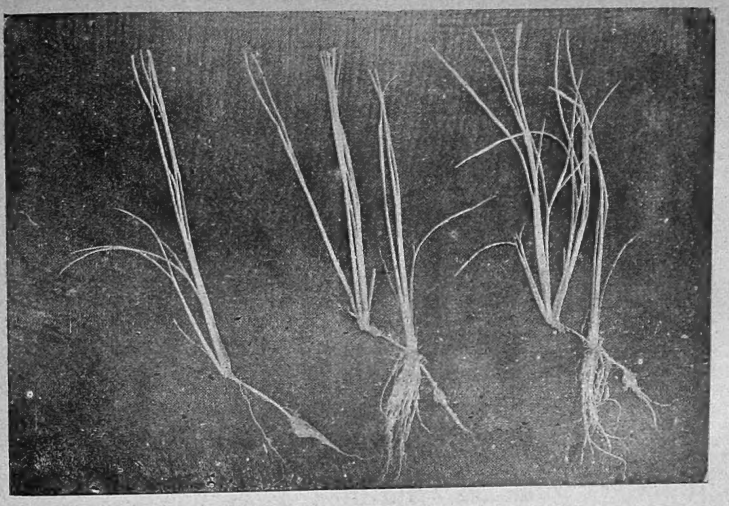
It is also possible that the ratio between the dry matter and the water content of a seedling may act as an index of the readiness with which a seedling establishes itself, as seedlings raised in a dry nursery or seedlings over-dried for want of irrigation establish quicker than those that are luxuriantly watered.

III. The root systems and how to study them—To demonstrate the two systems of roots and the tillers separately it is but difficult in the case of an ordinary seedling. For this, seedlings already noded in the seedbed were taken and planted in an oblique fashion. From Plate II Figure I, it will be seen that the parent seedling has produced roots at the bottom-most node and not nearer the base of its clump. These roots were only helpful in keeping the "Water-balance" of the seedling. But in Figure 2 we find the tiller produced at the first node, i. e., between the top parent shoot and the "Water-roots," developed a good bunch of roots. It will yet be found that no roots were produced at the base of the parental shoot. It is quite evident that the roots of the first tiller are "Nutrition-absorbing roots".

It will, therefore, be found that the variety that produces tillers in the early stages, e.g., *Akkullu*, as opposed to the variety that produces tillers gradually, e.g., *Kristnakatukulu* and *Atragada* will turn out to be a preferable one, as the early tillers are found to be "active workers" in the economy of the colony. It will also be found from Plate III that the parent seedling appears to remain parasitic for a long time by not producing "Nutrition-absorbing roots". This is again clearly demonstrated by the behaviour of the transplanted noded seedling. This behaviour cannot be clearly seen in a normal seedling amidst a bunch of old and fresh roots rising from a mass of shortly congested nodes. Separate study of the roots of the parent and daughter tillers can thus be conveniently made by this process, just as in sugarcane Rao Bahadur Venkatraman was able to study the "sett-roots" and shoot-roots separately. It will be seen from Plate III that a very good tillered plant has resulted out of the daughter tillers that were subsequently developed independently of the parent tiller. Though the parent tiller acts as a host for the first fortnight, it subsequently remains for a long time parasitic on the daughter and grand-daughter tillers because it does not develop roots of its own. This feature is also reflected in the size of the first earhead, in short duration varieties. This is comparatively poorer than the other heads, which emerge slightly later than the head of the parent tiller, but again the very latest heads are poor in size. This is generally experienced in many of the short and medium duration varieties, e. g., *Garikisannavari*, *Basangi*, etc. Probably this accounts for the fact that the Nitrogen content is in the ascending order of the emergence of heads, as noted by Engeldow [2] and others in their studies on barley.

PLATE II

"The Fate of the Primary Stem under Transplanted Conditions"
Primary Stem & Daughter Tillers with Their Root Systems.

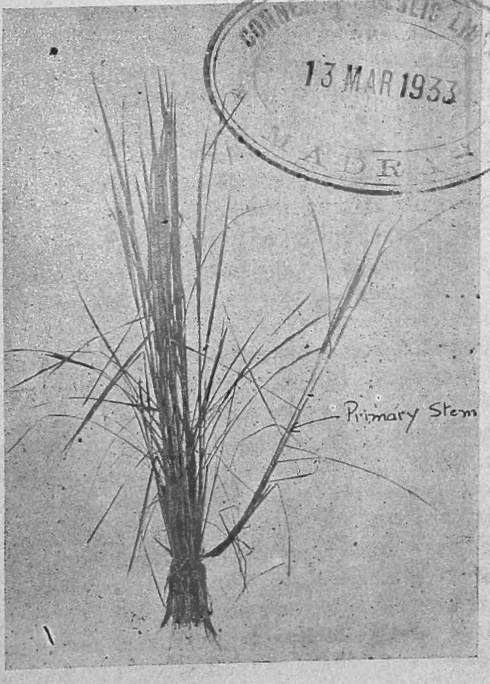


Note :–Fig 1. Absence of roots at the base of the clump. Roots produced are "Water Roots."

Fig 2-3. Development of daughter Tillers, with their "Nutrition-Absorbing" Roots.

PLATE III

"The Fate of the Primary Stem under Transplanted Conditions"
at Shot-Blade.



Note :- 1, The absence of Roots at the base of the Primary Stem
2. The well-tillered Stool is the outcome of the daughter & grand-daughter tillers.

It will be found from the studies of Sahasrabudde[7] on the "Assimilation of Nutrients by the Rice Plant," that there is a fortnightly increase of ash contents in the roots of a paddy plant, with a corresponding decrease in the same (ash-contents) in the intervening week. This shows the roots of the paddy plant are short-lived, *i. e.*, are produced at fortnightly intervals and function for a few weeks. It is a common experience to find ,whenever a paddy plant is pulled out, some old roots which have ceased to function identified by their slight brown colour and the fresh roots with their young active root tips. As the analysis given in Table 3 by Sahasrabudde indicates, it appears that the roots are produced at fortnightly intervals.

Table 3 Percentage of acid soluble mineral matter (on dry basis).

Days after transplantation.	14	28	42	56	70	81 Flag.	87 Milk.	103 ½ ripe.	109 Full-ripe
In roots of 100 culms.	11·72	8·55	11·5	9·9	11·9	7·7	7·5	11·10	10·90

This means that roots are produced afresh either from new tillers formed or from fresh nodes of tillers already formed or from both. It all depends upon the ratio of early formed tillers to late formed tillers. The fact that varieties which form tillers by slow degrees do not yield higher than those which finish their tillering in the early stages does not speak much of the ultimate use the later developed tillers make to the plants of the former type.

Table 4. Average yield in Decagrams per strip of 40′ x 5′ on the Agricultural Research Station, Maruter.

Year.	Akkullu.	Kristnakatukulu.
1927—28	766	760
1928—29	740	674
1929—30	750	817
1930—31	670	597
Bulk yields in lbs. per acre.		
1926—27	3,400	2,812
1930—31	3,223	2,802

We shall examine shortly how a good variety like *Akkullu* which finishes its tillering phase in the early stages behaves when secondary tillering is artificially induced by increase of spacing, thereby making a good variety like *Akkullu* to behave like *Atragada* which prolongs its tillering phase. It will be seen from the data given below that *Akkullu* acquits itself well even when it is made to suffer.

*** Percentage yield in different spacings.**

1927—28	1′ x 1′	1′ x 6″	* Bulk planting.
Akkullu	102	104	100
1928—29	6″ x 6″	1′ x 1′	
Akkullu	100	98·2	
Atragada	100	80	

They (later tillers) may either be a drag or of little help. In such a case it appears to be a sound proposition why such later tillering should not be discouraged by close planting. Apart from other disadvantages that are derived from pests etc. attacking at times the later tillers and converting the little energy into chaff (e.g , the *Kristnakatukulu* crop of this year on the Agricultural Research Station, Maruter, and the usual fate of *Atragada* in the delta), the later formed tillers do not seem to be of tangible help.

IV. Efficiency of a Tiller. Besides, the early tillering varieties, like *Akkullu*, will enjoy the full benefit of a manure applied before planting, thereby increasing the potential value or the yield per tiller, while in the case of varieties that develop tillers gradually, like *Atragada*, it is only a top dressing of manure that can give a substantial help to the later formed tillers. In the case of the latter, the yield per tiller will not be increased as the later tillers avail the use of the manure more than the early formed tillers. In the case of such varieties any initial dose of manure will only result in an un-uniform development of tillers and consequent un-uniform stand and flowering of the crop.

Table 5. Varietal differences in the "Efficiency of a Tiller" exhibited towards manuring.

Particulars.	Akkullu.	Kristna-katukulu.	Atragada.	GEB. 24
Unmanured				
Average number of tillers in 100 sq. ft. (average of 5 samples).	1859	1760	1305	2342
Average yield per 100 sq. ft. in grams. (Av. of 5 samples).	3090	2850	2935	2795
P. $E_d = \pm 3{\cdot}37\%$ Average yield per tiller in grams.	1·66	1·62	2·25	1·19
Manured				
Average number of tillers in 100 sq. ft. (av. of 5 samples.)	1933	1888	1541	2616
Average yield per 100 sq. ft. in grams (av. of 5 samples).	3535	3325	3539	3345
P. $E_d = \pm 2{\cdot}4\%$ Average yield per tiller in grams.	1·83	1·76	2·20	1·28

* Unpublished record of Agricultural Research Station, Maruter.

Indirect method				
Percentage of manured over unmanured.	14·4	16·6	15·5	19·7
Increase percentage of tillers due to manuring.	3·94	7·23	18·15	11·65
∴ Percentage increase of "Efficiency" of a tiller due to manuring.	10·46	9·32	...	8·05
Direct method.				
Average yield per tiller in grams (unmanured condition).	1·66	1·62	2·25	1·19
Average yield per tiller in grams (manured condition).	1·83	1·76	2·20	1 28
Percentage increase in yield or "Efficiency" of a tiller due to manuring.	10·2	8·6	...	7·6

From a review of Table 5 it will be found that *Akkullu* by virtue of early tillering responds to manuring by increasing the efficiency of the individual tiller rather than by increasing the number of tillers. The number of tillers in both manured and unmanured conditions is about the same within limits of error, while *Atragada* increases its yield by increasing the number of tillers, the average efficiency of a tiller being little disturbed. Though it cannot be said that the efficiency of a tiller is not increased by manuring in any variety, the behaviour of *Atragada* has to be understood in the sense that the early developed tillers have slightly increased their efficiency (due to manuring), which is compensated by the low efficiency value of later developed tillers, thus keeping the average efficiency at par much undisturbed.

The "Efficiency" of a tiller is the comprehensive resultant of many forces, physical, physiological and environmental: and may therefore be examined under the influence of the following factors:— E.g., (a) Varietal characteristics as regards the tillering capacity of the plant (b) artificial improvement of tillering by cultural methods, e.g., spacing and (c) by manurial resources (d) crowding in a hill or bunch planting (e) and duration of the variety or sub-variety. Though it will not be possible to deal with all of them comprehensively due to limitations of space, experimental data will be cited just to elucidate the importance of the above factors.

(*a*) *Varietal.*— The efficiency of a tiller or yield per tiller has been found to be generally negatively correlated with the tillering capacity of the plant. This has been the general experience in the study of a large number of types. But this fact could better be elucidated from the population of cross progenies—crosses between two divergent

parents, i.e., widely differing in yield characters. For example, in T.24 × T.277 (unpublished record of the Paddy Breeding Station, Coimbatore).

$$r_{t.y} = -0.487 \pm 0.033$$

(t = number of tillers per plant; y = yield per tiller or "Efficiency of a tiller")

This significant negative correlation indicates to some extent that the yield per tiller suffers by improvement in tillering; while the results of ENGELDOW and RAMIAH on 3 varieties of wheat show that the yield per tiller and especially of that of the main axis (T_o) ear is enhanced by improvement in tillering. Though the difference in behaviour cannot be correctly explained, it may be surmised that the broadcasting (results obtained on wheat) or transplanting (results obtained on paddy) might have been a potent cause, or other factors (in paddy) like coarseness of grain size, bunched character of the ear-head, etc., acting as associate attributes in a partial correlation might have resulted to yield a significant negative correlation between tillers per plant and yield per tiller.

(*b*) *Artificial improvement of tillering by cultural resources—spacing*. The above data lead us on to other studies of improving the tillering capacity of the plant by cultural means—spacing—and studying the behaviour of the yield per tiller.

Table 6 reveals the results of a spacing experiment conducted on 4 of the Coimbatore strains (experiments conducted at the Paddy Breeding Station, Coimbatore in 1924–25—Unpublished record).

Table 6. Percentage yield of strains in different spacings.

Strain.	3″ × 3″	6″ × 6″	9″ × 9″	12″ × 12″	Remarks.
GEB. 24	157·4	147·4	140·7	100	
Co. 1.	103·6	103·2	106·8	100	
Co. 2.	98·9	101·7	102·8	100	
Co. 3.	100 9	99·8	102·4	100	

The spacing experiment, simple though it be, reveals the sharp inter-varietal physiological differences. In the case of Co. 1, Co. 2, and Co 3, the relation (within limits of error) between yield per tiller and number of tillers per plant seems to be a compensative one as expressed by the equation

$$Y_u = Y_t \times t$$

or t varies indirectly as Y_t or *vice versa* while in the case of GEB.24, Y_u varies directly as t thus making Y_t a constant quantity K, because the number of tillers per unit area increases with closer spacing as found out by Srinivasa Iyyengar[8] in his spacing studies on Kuruvai and also by a Philippine Worker on rice [9]. (Y_u = yield per unite area ; Y_t = Yield per tiller ; $_t$ = number of tillers per unit area).

(c). *By manurial resources* — This feature of the problem has been fully elucidated by the data in Table 5 to show that the

"Efficiency" of a tiller responds to manuring in *Akkullu* and does not do so in *Atragada*.

(d). *Crowding in a Hill—Bunch planting*— Though much of experimental proof has not accumulated to demonstrate the effect of crowding in a hill on the efficiency of a tiller, some glimpses of importance can be had from the figures of Srinivasa Iyyengar [9] his work on *Kuruvai*.

Spacing	No. of Seedlings per hill.	Yield per tiller.	Remarks.
3″×3″ i. e. 9 sq. in	1	1·18 gms.	In an area of 36 sq. inches 4 seedlings planted *separately*.
6″×6″ i. e. 36 ,, ,,	4	1·36	In an area of 36 sq. inches 4 seedlings planted *in a bunch*.

This shows that in planting 4 seedlings in an area of 36 sq. inches all the seedlings placed in one hill the "efficiency" of a tiller is increased over that obtained in planting the very same 4 seedlings in the very same area of 36 sq. in., but only the seedlings placed individually at 3″×3″ spacing. Recent work elesewhere has also shown that "sowing cereals in pockets [10]" at wider spacing has given better yields and helped the crop to combat unfavourable seasons than drill sowing in lines or sowing fewer grains in closer spacing. Crowding or bunch planting has shown that the number of tillers developed per plan, will be less as the number of seedlings per hill increases, and the fact that the more the secondary tillering is inhibited, the more the yields, shows that by crowding the efficiency of a tiller is enhanced. This very well falls in a line with the significant negative correlation obtained between yield per tiller and number of tillers per plant Also the agronomic value of the practice of bunch planting is testified to by the heavier yields even in short duration crops of paddy obtained in the Tanjore district of Southern India.

(e). *Duration*. On the basis of the findings that in closer spacing the number of tillers per unit area is more than in wider spacing and that the number of tillers per plant is more in wider spacing than in closer spacing, it will be seen that a late selection of a particular variety is preferable to an early selection on considerations of the physiology of yield.

Percentage yield of 2 selections of different durations in Garikisannavari. *

	1'x 1'	1'x 6"	Bulk planting.
Late bulk.	93·4	95·3	100
Early bulk.	82·66	96·7	100

*Unpublished records of Agricultural Research Station, Maruter.

The figures definitely show that in the late bulk the "Efficiency of a tiller" is more of a desirable type in as much as it possesses compensative qualities, while that in the early bulk, no response is exhibited to spacing.

V. Conclusions. Studies in the physiology of crop plants is of the utmost necessity, as any economic work undertaken can have a firm fundamental basis to start with: and the physiological insight will lend a greater amount of guidance than when economic work is started without it. In all endeavours for economic improvement of a particular variety or practice, work, without the aid of fundamental physiological work, goes astray uncontrolled to pursuit of side issues.

In the course of the paper, the position of a tiller in "a colony of tillers"— a plant—from the beginning of its life is traced.

1. The process of tillering is shown to be a result of light perceptive powers of the paddy plant.

2. The primary stem under transplanted conditions, though for a time acts as a host for subsidiary daughter tillers, remains for a long time as a parasite on the daughter and grand-daughter tillers. The case of the manured seedling is discussed.

3. The existence of two different root systems, viz. "Water-roots" and "nutrition absorbing roots" is clearly brought out and their functions explained with confirmatory evidences from other crop plants.

4. The fact that varieties which finish their tillering in the early stages yield better than those which prolong their tillering phase, has been amply illustrated.

5. The importance of the "Efficiency of a tiller" has been clearly made out and the extent of the effect of the various factors operating on it been correctly assessed.

VI. Acknowledgments. I am greatly indebted to M. R. Ry. K. Ramiah Avl., M. Sc., Dip. Agri. (Cantab), Paddy Specialist, and M. R. Ry. C. R. Srinivasa Iyyengar, Avl., L. Ag., Superintendent, Agricultural Research Station, Maruter, for their valuable criticisms and guidance in the writing of this paper and for kindly permitting me to use some of the unpublished records of the experiments conducted at the Paddy Breeding Station, Coimbatore and the Agricultural Research Station, Maruter.

Postscript.

Since the submission of the article to the Union, an article under the caption "*Sorghum—Studies in sowing depths*" by Messrs G. N. Rangaswami Ayyangar and K. Kunhi Krishnan Nambiyar appeared in the May 1931 issue of the *Madras Agricultural Journal*. The conclusions arrived at by the authors confirm mine fully with respect to the experiments on depth of sowing. But the suppression

of the length of the hypocotyl in the presence of light (Plate I, Fig. 2) could not have been observed in Sorghum, probably as the experiments were conducted either in the field direct or in flower pots.

The differntial behaviour of one strain from another towards different sowing depths and the consequent indication of a need for a study in the general scheme of evolution of a successful strain further reiterates the existence of minute physiological differences between varieties of paddy as elucidated in the body of the paper.

List of References.

1. HARLAN H. V. — Some distinctions in our cultivated Barleys with reference to their use in plant breeding-- ***Bulletin of U. S. Department of Agriculture*** No. 137.

2. ENGELDOW AND WADHAM. — Investigations on yield in cereals Series I and II -- ***Journal of Agricultural Science*** 1923, 1924.

3. ENGELDOW & RAMIAH K. — Investigation on yield in cereals VII. ***Journal of Agricultural Science*** 1930,

4. JOHN PERCIVAL, — The wheat plant.

5 VENKATR AMAN T. S. AND THOMAS R. — Studies of Sugarcane roots at different stages of growth -- ***Pusa Memoirs***-- Botanical series Vol. XVI No. 5.

6. MAGISTAD O. C. & TRONG E. — Influence of fertilisers in protecting corn against freezing. ***Journal of American Society of Agronomy*** Vol. 17 No, 9.

7. SAHASRABUDDE, — Assimilation of nutrients by the rice plant ***Bulletin No. 154 of 1928 of Bombay Department of Agriculture.***

8. SRINIVASA IYYENGAR C. R. — Preliminary investigation on the limit of economic planting of paddy (Kuruvai crop) in the Tanjore Delta. ***Year Book 1925-- Madras Agricultural Department.***

9. — Effect of spacing on tillering and production of three rice varieties--***Philippine Agriculturist*** June 1924.

10. — Sowing cereals in Pockets---***International Review of Agriculture.*** Monthly Bulletin of ***Agriculture Science and practice*** 1930.

THE COCONUT CATERPILLAR IN COCHIN

(*NEPHANTIS SERINOPA* MEYR).

BY C. S. VENKATASUBBAN, B. A., B. Ag.

Entomologist, Cochin State.

Introduction. Cochin is a small feudatory Native State along the Malabar coast in South India. The climate is warm and moist, the rainfall ranging from 70 inches in the extreme eastern part of the State to about 150″ in the coastal regions. The principal crops are paddy and coconuts.

Coconut Crop in Cochin. Although coconut is grown throughout the State, it is the predominant crop in the coastal regions, which are generally referred to as the "Coconut tracts". The margins of the sea coast and the "Backwaters" are lined by numerous coconut gardens which form the mainstay of the farmers in these localities. The trees grow luxuriantly and demand little in the way of cultivation and manuring unlike those grown in the interior. As is well known, coconut is a very profitable crop, every part of which has important economic uses.

Insect Pests of Coconut in Cochin. Till recent years the crop was rather immune from severe pests. The palm beetle *(Oryctes rhinoceros)* though present, is not so bad in these coastal gardens as in the interior. The same remark applies to the weevil (*Rhynchophorus ferrigineous*). From the writer's observations for the past seven years we may state with some amount of confidence that the palm weevil is an extreme rarity in the sandy soils characteristic of these regions. *Parasacrepida* and *Conthyla rotunda* the two slug caterpillars occur sporadically, but their infestations are confined to small areas only.

The Coconut Caterpillar. A new enemy appeared in these tracts in the year 1924, and since then has been doing damage to many coconut gardens. This is *Nephantis serinopa* Meyr, a moth of the Xylorectidae family. The writer has been working on the control of this new invader from its very entry into the State, and this paper is an attempt to embody his observations on the pest for the past seven years, and the results of the control measures directed against it.

History of the Pest in Cochin. There is no evidence of this pest as having been found in coconuts before the year 1924. It has been observed in palmyra palms which are found in many parts of the State, especially towards the interior. About the months of July and August in the year 1924, there was abnormal rainfall in the State resulting in destructive floods particularly along the coastal regions. Soon after the subsidence of these floods the pest *Nephantis Serinopa* was noticed to have infested the trees. In fact the farmers here associate the floods and the pest as having some definite relation and when any of

* Paper submitted to the Indian Science Congress, Bangalore, 1932.

them is questioned about it, the invariable reply is 'the floods brought the pest along with it". It is quite likely that the pest might have come with the floods, and all evidence points to this conclusion. These coastal areas of the State are continued into the South by the coastal tracts of the adjoining State of Travancore, and to the north by the British Malabar coast. Kayamkulam, one of the coastal towns in Travancore, was known to be a centre of infection of this pest, and the Travancore Entomologist had referred to it as occuring in this place in the year 1918. † During the floods it is very likely that fronds and even trees from this infested place in Travancore State might have been transported with the water and deposited all along the way, thus providing fresh habitats for the pest. This view is further confirmed by the fact that all places to the north of Kayamkulam in Travancore State got the infection for the first time only after the above mentioned floods.

Life History. The life history of the pest is as below. Eggs are laid in batches on the underside of the leaflets, and the caterpillars on hatching feed on the lower epidermis of the same. They construct a gallery composed of leaf scrapings and excreta tied together with silk. The caterpillars always live under these galleries which are extended wherever they move as is the habit with white ants. Pupation takes place inside these galleries. The moths are sluggish and remain closely attached to the leaves or stem of the trees. I have not observed them flying even at night time. The life history occupies about fifty days to one and a half months.

The caterpillars gnaw the undersurface of the leaves leaving only the thin upper epidermis which soon dries up. The infection starts from the lowermost ring of fronds, a few leaflets of which are first attacked. Gradually the whole ring of fronds gets completely infested, while at the same time, the pest spreads to the upper rings. In this manner in about two to three months from the commencement of the attack, almost the whole of the fronds of the tree except a few at the top are infested. A single leaflet has been noted in severe infections to contain as many as a dozen caterpillars whose galleries are contiguous, so much so that the entire leaflet is reduced to a thin dried-up membrane, which in time gets torn off either by wind, sun, or rain, leaving only the midrib. This drying up of the leaves and the resultant skeletonizing, form the characteristic damage done by the pest. From a distance the infected trees appear as if they have been scorched by fire.

Although the pest appeared towards the close of the year 1924 soon after the subsidence of the above mentioned floods, it was brought to the notice of the Agricultural Department only some months later. At first the pest would have occurred only in small patches, and the

† Proceedings of the Entomological Conference, Pusa. 1918 Vol. I P. 157.

gardeners apparently cared little about it. But the infection continued to increase and spread so steadily that by June 1925, it was observed that long lines of gardens fringing the back waters and the coast were attacked badly. These lines in some cases extended from three to four miles in length involving thousands of trees. The alarm was given only after the situation reached this extreme stage. Such was the severity and extensiveness of the attack in June 1925 that farmers were raising the hue and cry, "The plague would surely exterminate all coconuts along the coast."

Action taken by Government. (a) *Mechanical Methods* :—Since this was a new pest the State Agricultural Department was at first in a dilemma as to how to deal with an enemy which had occupied such a vast extent of ground in a short time. But one thing was clear. The examination of the leaves at this time revealed a large number of caterpillars and pupae. The removal and burning of these infested fronds could not create more harm to the trees than what they had already suffered at the hands of the pest, since dried and skeletonized leaves are of no further use to them. On the other hand this step, besides destroying in its initial stages such large numbers of the pest, will surely prevent its subsequent increase and spread to a great extent.

But how was one to carry out this operation successfully over large areas, involving. as was found afterwards, nearly a lakh of trees? The farmers resigned to the delusion that the trees have been irrevocably lost to them, were absolutely unwilling to fight an enemy against which, they thought, no human efforts would be of any avail. Not only that, they characterised the operation of "Removal and burning of the infested fronds" as only a mad act supplementing the work of the pest and ensuring the speedy destruction of the trees. Under these conditions the Pest-Act in the State was brought into force, and the Agricultural Department by the engagement of special staff treated nearly a lakh of trees in the months of July, and August 1925. During these two months, there was nothing but fires of burning fronds in these gardens. The Agricultural Department, which was but newly started, was condemned as bringing havoc to the people. The enlightened public of Cochin represented by the members of the Legislative Council were loud in their protests at this action of the Department whom they expected to devise some insecticidal method of combating the pest. But the Department steadily carried on with the treatment deaf to all these protests and dissentient voices, and by the end of September 1925 nearly a lakh of trees were treated.

The result of this drastic action proved to be quite contrary to what the public expected. Not only was a single tree not killed solely because of the removal of its infested fronds, but the pest was almost put down and by the month of October 1925 it was noticed that its numbers were reduced to negligible proportions. This beneficial position

was, however. reached not solely due to the above operation alone. It must be evident that it is not possible to completely remove all the infested leaves from a single garden, not to speak of a big area, and there must always remain—ever under the most rigid of cutting operations—a small percentage of untreated leaflets whose occupants would surely multiply in course of time. But this eventuality was checked by the action of beneficial insect friends.

During my observations in the months of July and August 1925 when the pest was most severe, there were found isolated cases of parasitism amongst caterpillars and pupae but after the above operation, examination of the remnants in September and October 1925 revealed that a good percentage of the caterpillars and pupae were parasitised. The following are the important insect enemies of this pest in Cochin, but for whose help it would continue to have had unrestricted sway.

(1) *Stomatoceros sulcatiscutellum, G.* This is a fairly big chalcid which infests the pupa. It is one of the commonest parasites found throughout the year, but its effectiveness is limited since the fecundity is poor.

(2) *Elasmus nephantidis, Rohw.* The eggs are laid on full grown caterpillars. The grubs feed on the host reducing the same to a shrivelled skin round which they pupate. This is a very effective parasite possessing a fair amount of fecundity. Unfortunately it thrives only during the cooler months of the year, and its numbers get considerably diminished during the hot season.

(3) *Microbracon serinopae*—Ramakrishna (MS) This is also found infesting grown up caterpillars. The white silky cocoons of this parasite on the underside of the leaflets are very characteristic. It is more common than Elasmus sp and effects a good control on the pest. Besides getting reduced during the hot season it is also subject to hyperparasites.

(4) *Bethylid sp.* This also attacks caterpillars round whose shrivelled skins, the silky cocoons of the parasite are found in a mass. This too is an effective parasite, but like microbracon it is hyper-parasitised to some extent.

(5) *Eulophid sp.* This minute ant like insect is the most effective of all parasites in Cochin. The species infest the pupae from a single one of which large numbers of parasites are bred out. The pupa is reduced to a thin capsule full of these tiny parasites. In September 1925 it was found that almost every pupa was infested by this parasite. The life history is short and the fecundity great. In fact, when conditions favourable to Eulophids prevail, the pest has no chance of increase at all. Unfortunately these delicate insects are very sensitive

to heat, so much so that during the hot months of April and May it is very difficult to find even a few specimens of them in the field.

Besides the above there were also two other parasites, (hymenopterous) which used to be rarely met with. A small reddish brown carabid beetle is found, especially after the rains in July—August in fairly large numbers feeding on the caterpillars and pupae, and doubtless exercises an appreciable check on the increase of the pest. The same is true of an Anthocorid bug (*Triphleps sp*) which has been observed sucking the eggs and young caterpillars.

Results of Control Measures. The happy result above referred to was thus not due to the operation of "cutting and burning" alone, but also equally due to the check exercised by the above-mentioned insect friends. From September 1925 till the outbreak of the next hot season in May, June 1926 the condition of the treated gardens remained very satisfactory, while there was no spread of the pest to new areas. But with the advent of this hot season the situation changed. About the end of June 1926, it was noticed that some of the gardens treated in July and August 1925 were re-infested, and also that the pest had invaded fresh areas along the coast. The intensity of these attacks, however, was considerably less than that of the previous year. Examination of the leaves showed a great dearth of parasites. This was particularly true of *Eulophid sp.* These infections were dealt with in the same manner as before, namely by the removal and burning of the infested fronds, and by the end of September 1926 the situation was well under control. Henceforward the history of the pest till now is nothing but a repetition of the situations above referred to. Generally at the close of every hot season fresh outbreaks of the pest occured, which used to be promptly dealt with, and the condition of the gardens remained satisfactory during the rest of the year.

The pest breeds throughout the year, but its numbers are kept under check by the parasites and predators mentioned above. Unfortunately in the hot season, these parasites, especially the Eulophids, dwindle down to a considerable extent, and this explains why the pest gets a chance of increase soon after the hot months. The treatment of the gardens in July, August etc. reduces the pest considerably, while the advent of the rains and the resultant cooling of the atmosphere give a filip to the parasites which soon increase and bring the situation under control.

How does the removal of the leaves affect the health and productivity of the trees? What will happen if no operation at all is conducted and the pest allowed to have its own way? It has already been stated that pruning of the leaves has not killed a single tree, provided it had been in normal health. Diseased trees with attenuated stems, possessing only a spare number of sickly and undersized leaves suffer by this treatment. But in these cases treatment only hastens the end which

would have occured even without it. There had been instances where I had occasion to prune the leaves of trees every year for three years in succession. Subsequent behaviour of those trees showed that they were little affected, if at all, by these treatments. As regards production the following changes occur. The half and three fourths ripe nuts found on the tree at the time of treatment fail in most cases to mature and drop down unripe, owing to the denudation of most of its leaves. The trees fail to produce anything for an year after this. During the second year, however, it has been observed as a general rule that the trees yield much better than what they ordinarily used to do, thus justifying the statement that "the removal of the leaves has a sort of 'Pruning effect' on the trees."

To test the consequences of leaving the pest uninterfered with, I had during the year 1927 left certain gardens unoperated. It was then seen that although there was severe infection at first the trees were much better in 1928, and by 1929 most of the infection had died out. The health of the trees did not apparently suffer, but production was low for a year, after which it became normal. Subsequent experience, short though it may be, has only confirmed these results. Thus, it has become apparent that even without cutting and burning the infection dies out. Only the process is very slow.

Notwithstanding this fact, it is very desirable to have recourse to pruning at the right time. By right time I mean just at the initial stages of an outbreak when there are large numbers of the pest, and the parasites rare. This will give a better chance to the parasites by reducing the numbers of the pest, and relief is obtained much quicker. Secondly pruning in the initial stages will not weaken the trees much, since the number of leaves to be operated will be small. Thirdly pruning does much to prevent the spread of the pest to new areas. It has been noted that although infected trees recover without any treatment, the pest spreads to new areas. This is obviated to a great degree by pruning.

With regard to the incidence of attack it has been noted that weak trees standing on low undrained situations are more easily affected than those growing on higher and well drained ground. Also well cared for trees suffer less and recover soon from an attack than neglected ones. I conducted some manurial trials to see how far this will help the trees against the pest, and the result was that manured trees recovered soon from an infestation, and showed a more or less definite tendency to withstand re-infestations.

Outbreaks of the pest still occur in the old, as well as in fresh areas, but compared with earlier infestations they are very mild. This phenomenon together with the fact that the infection passes away of itself, leads one to believe that *Nephantis sp.* is not such a bad pest

as it was originally thought to be. Unless a large percentage of the fronds of the tree is affected, no appreciable damage to the health or productivity of trees takes place. Far from confining itself to the coastal areas as before, it has begun affecting palms in the interior also, but the attacks are very mild and subside naturally.

The State Department is still vigilantly working to see that outbreaks of the pest that show a tendency to increase and spread are promptly dealt with. Intensive propaganda to educate the ryots regarding the life history of the pest and the significance of the control measures advocated, has been, and is still being carried out by means of leaflets, meetings, exhibitions etc., and it is hoped that before long, they will be able to deal with the pest themselves without the intervention of the Department.

Acknowledgments. In conclusion the writer has to express thanks to the Superintendent of Agriculture, Cochin State, who has been his main guiding force, and to Rao Sahib Y. Ramachandra Rao and Dr. T V. Ramakrishna Iyer of the Madras Agricultural Department for help in identifying specimens, and for various suggestions in this work His thanks are also due to the brother officers of the Department for the collaboration in the work of checking this pest.

STATISTICS IN RELATION TO AGRICULTURAL EXPERIMENTS.

The above was the subject of a lecture delivered by Mr. M. Vydianatha Ayyar, Statistician to the Imperial Council of Agricultural Research, during his recent visit to the Research Institute. Before he took up the subject proper of the lecture he briefly outlined the nature of work performed by the Research Council on the economic side. The rapid fall in the prices of jaggery, wheat and rice produced in the country, and the public agitation asking for protection made the Government of India refer the matter to the Research Council to investigate the necessity for such a protection. The Statistical Department undertook to collect data on the various points concerned in the question by making rural enquiries in several parts of the concerned provinces. While they found that there was a case for protection in the case of jaggery and wheat the question was not so easy of solution in the case of rice. Since rice is being produced mainly for consumption in the country with very little of export trade in it the only thing that could be recommended was the reduction of railway freights paid for moving the produce from one part of the country to another. The question of oil-seeds was next taken up, and the Oil-seeds

Committee is investigating the matter. This is, of course, bound up with the question, how far the country can afford to export the oil-seeds after meeting the manurial requirements of the country. Probably a specialist officer would have to investigate how best the raw products could be utilised in the country itself.

The next question taken up by the Research Council was the subject of preparation of crop forecasts in the country. In countries like America the crop forecasts are prepared on a scientific basis by a special staff of crop reporters and even there, differences of 25 per cent. have been observed between the forecasted and the actual figures. How deficient this preparation of forecasts should be in India where the village *karnam* is the basic authority for such figures need not be expatiated. In the case of cotton, where complete data regarding production and consumption can be obtained, there has been found a discrepancy of nearly 50 per cent. between the actual and the estimated figures.

In the case of industrial crops, like cotton, jute and oilseeds, the production is bound up with the existing marketing facilities So organisation of better marketing facilities for such products has also come under the purview of the Research Council. In the case of Bengal jute, for instance, the whole business is in the hands of a few European firms and nowhere else have we such an organisation for any other crop. Such organisations are particularly absent in the province of Madras, and it is a happy augury that the Government have taken up this question recently.

As regards agricultural experiments he stated that provinces like the Punjab and the United Provinces often sought the help and advice of the statistical section of the Research Council. In some of these places agricultural experiments have been continued for long periods of 30 to 40 years without any replications. Though the modern statistical methods cannot be applied to the results of these experiments, they are still advised not to scrap the experiments but continue them, in as much as the results could be utilised to determine the periodicity of yield, the effect of rotations, manures, etc. The modern methods of experimentation, he thought, are not yet sufficiently appreciated. Fisher, whose analysis of variance must be considered a monumental work, was, unfortunately, often misunderstood. It is stated that randomisation is not easily defined, and even in a random arrangement we could get an order which is systematic. Before applying Fisher's methods to the data, he said, all the implications must be sufficiently understood and the data subjected to good scrutiny. The yield figures must first be examined as to whether they follow any law when plotted. The figures should be perfectly at random and the number of samples sufficiently large for making use of Fisher's T table. He observed that 2 or 3 determinations would certainly be too few to use

the T table, whereas it could be used with caution in the case of 5 to 10 determinations and for determinations of over 10 it could certainly be used. In large samples though curves other than normal could occur in the case of agricultural experiments it might be taken that the distribution of variables does not materially differ from the normal curve.

As regards the question often asked, 'how long are the experiments to be continued,' there cannot be any hard and fast rule. If two years' results would not agree, naturally we must repeat it a third year. According to Fisher, every experiment must be self-contained with no necessity for repetitions, but this view has been stoutly opposed by several others. In countries like India where season is definitely known to exercise great influence on yield, every experiment must be repeated a number of times and the results combined. Even in combining results great caution should be exercised. If there was any abnormality observed in the case of a particular plot it would be better to repeat the experiment and discard the abnormal figure from the results if it was not borne out by the second trial also. In America five years have been fixed as the minimum period for running an experiment before the effect of seasons could be judged.

Correlation tables and the correlation co-efficients are often used in interpreting biological data. It must clearly be understood that the correlation co-efficient calcualted by the 'product moment method' can only be used when the samples are sufficiently large and the frequencies of each sample follow the normal curve. Fisher's analysis of variance could, however, be more safely used in most of these cases. Though this method does not determine the actual amount of relationship between the two variables it will show whether the correspondence between the two exists or not.

The lecture was followed by an interesting discussion in which several people took part.

(K. R.)

AUSTRALIAN DAIRYING INDUSTRY.

By L. T. MAC INNES,

Director of Dairying.

As far as amount of capital invested by the primary producer and in regard to the number of people directly dependent on dairy farming are concerned, dairying is considered by many to be the most important of the primary industries of Australia. In estimated value of production on last year's production and price levels, the Australian dairying industry returns to the producer almost as much as the pastoral section and in excess of those of other sections. The volume

rate of increase of dairy products for the years 1930–31 and 1931–32, is greater than that of wool and wheat. The values received for dairy products are stabilised and give better security and assurance to the farmer owing to (a) monthly payments, (b) producer control of manufacture and marketing. These better marketing conditions and values have caused a very big swing over to dairying in areas which previously were a monopoly for wool and wheat.

Increased production has more than balanced the fall in prices. The experience in this State is exemplary of that of Australia in this respect.

New South Wales Butter Budget.

Year.	*Average Price.*	*Value Realised.*
1929.	£ 180 per ton.	£ 7,298,000
1930.	£ 164 per ton.	£ 7,351,006
1931.	£ 150 per ton.	£ 7,718,000 (Inc. Exchange).

The increase in butter outputs over these years was: 1929—30, 4000 tons ahead of 1928—29; 1930—31 gave a further expansion of 7000 tons, making an aggregate increase of 11,000 tons in the 3 years. The output in New South Wales for 1930—31 was over 51,000 tons of butter (butter is taken to illustrate the progress made, because over 80 per cent. of the annual milk yields of the dairy herds is converted into butter). Forty years ago the output for all Australia was under 30,000 tons, while that for New South Wales was about 8000 tons (year 1890). For 1931, Australia's output was 144,000 tons of which 74,000 tons valued at nearly £ 9,000,000, were exported overseas.

The Progressive Story. For the current year, 1931–32, production to 31st January shows a marked increase in all States. It is expected if the conditions remain favourable that the output of New South Wales will exceed 60,000 tons, and that of Australia will reach about 175,000 tons, of which 90,000 tons should be exported, adding some £ 11,000,000, to our national wealth. In 1890 dairy cattle were recorded separately for the first time in New South Wales and were found to number 333,023. In 1930, there were 2,686,132 cattle in New South Wales, and 11,202,134 in Australia, of which 959,494 and 2,464,940 were dairy stock in New South Wales and Australia respectively. In 1889, 144,366 cows produced 497,464,000 gallons and in 1930, 2,464,930 cows produced 828,521,000 gallons. The value of the total milk production for 1930 was £ 12,630,000 in New South Wales, and £ 38,700,000 for Australia. To these totals should be added the accrued values for young cattle, pigs and pig products.

Increase in Yields. The increase in yields of dairy cows in New South Wales has been as follows:—

Year.	*Lb. butter per cow.*
1921.	120
1928–29.	159
1929–30.	177
1930–31.	191
1931–32 (Estimated)	210

Total increase in 10 years is 71 lbs. per cow equal to 59 per cent., or 7·1 lbs. per cow per annum. In the last 20 years New Zealand cows have increased 70 lbs, and in the last 22 years those of Denmark 50 lbs. New South Wales in half the time has shown an increase of 71 lbs. under the disadvantages of irregular rainfall and bad droughts, which are unknown factors in New Zealand and Denmark. It is expected that the average butter yield per cow will further increase for 1931-32 by 20 per cent., and should be about 230 lbs. if rainfall conditions remain good. These yields represent the average of all cows that pass through the bails, if only for one day, during each year. They cannot be compared with the averages compiled in New Zealand, Denmark, Victoria and other dairying centres, as there the averages are got from selected cows, those with complete single lactation periods, or as in New Zealand, with at least one hundred milking days' production to their credit.

Quality Improvement. Now turn to quality improvement. All primary products are sold on quality and not only that, but the consumption rate per head is based on whether the quality is good or bad. Take the history of butter manufacture, for example:

In 1916 the average annual amount consumed in New South Wales was 22 lbs; in 1930-31 it was, in spite of the industrial and financial crisis, 34 lbs. Low consumption went with bad quality in 1915. As the percentage output of choicest went up so also did the consumption rate. New South Wales on a factory output of some 49,000 tons marked about 47,000 tons as choicest grade. There were 14,000 tons exported overseas of which 90 per cent. (12,600 tons) was choicest and carried the Commonwealth "Kangaroo" brand of excellence. The local market requirements, 38,000 tons were met with choicest quality. New South Wales gave preference of quality to its own consumers, the local being the valuable market.

The Future. At the present time and under existing Empire trading conditions, there is a market for all the dairy produce we can produce. The weakness of the position lies in having to accept a low overseas price.

As with other industries the future rests on the outcome of the Ottawa Conference (preference tariff *and* quota, not preference *or* quota). Should an Empire trading arrangement eventuate from those

deliberations, giving all Dominions the benefit of (a) Empire tariff against outside world competition (b) intra and inter-Empire preferential trade, (c) quotas of each Dominion's markets, the future is bright for all. — *Country Life*, March 15—1932.

AGRICULTURAL NOTES FROM THE NORTHERN TALUKS OF GANJAM DISTRICT

By V. TIRUMALA RAO, B. Sc. (Ag).,

Assistant to the Government Entomologist

and

M. GOPALA RAO,

Assistant Agricultural Demonstrator, Berhampur.

In the Goomsur taluk of the Ganjam District there is the practice of sowing peas in a standing crop of paddy, and leaving long stubbles of the latter at the time of harvest for the pea plants to support themselves. Since there is a good local demand for peas this practice is worth trying in other areas of the district, especially in plots where early varieties of paddy are grown.

* * * *

In the Tanganapalli village the cultivation of paddy is limited to two chief varieties, viz., *Ratnachuli* and *Bayalunda*, and special care is taken to keep up the purity of these varieties. In addition to the usual care in the field as well as in the thrashing floor, the earheads are examined individually once in three years or so for weeding out red rice, and the grain so purified, for white rice forms the standard for further multiplication and seed distribution. There is sufficient recognition in the Berhampur market of the superior quality of *Tanganapalli* paddy, and it carries a premium of at least annas 8 per bag. In these days of agricultural depression when ryots are unable to find a sale for their produce even at the low prices quoted, Tanganapalli is able to readily dispose of its paddy in the Berhampur market, where there is a never failing demand [for it]. The village as a whole does not feel the scarcity of money as much as other villages, and this shows how the villages near important towns can build up a reputation for their produce by honestly following good agricultural practices.

* * * * *

In the Purushothapur area of Chatrapur taluk there is the practice of discarding first sown paddy nurseries when the planting season proves to be late, and the raising of late nurseries to have seedlings of a suitable age for planting. The ryots realise the value of using

paddy seedlings of a proper age for transplantation, and think that the trouble taken in the raising of separate late nurseries for late seasons is compensated in the increase of the out-turn.

* * * * *

When *Gonda Manji* (Short crop) sugarcane seed material is used for planting, the Ganjam ryot discards the tops, but this is not the case when matured canes are used. In fact the tops of mature canes are known to give better germination than the other parts of the cane, but in a test with short crop material it was found that the tops are poor in germination, probably because of the absence of proper development of top buds in a slow growing cane.

* * * * * *

On account of the uncertain weather conditions prevailing during the monsoon season in the Ganjam district the drying of paddy grain before hand-pounding is difficult. To overcome this some of the villagers dry the grain before the advent of the monsoon, half pound it, and preserve it in paddy twists. Whenever rice is required the half pounded paddy gets the final finishing without any subsequent drying.

* * * * *

During summer when betel leaf has to be exported to distant places there is the practice of sprinkling mustard and ragi seed between the leaf layers packed in baskets. It is said that the seed so sprinkled at the rate of about two ounces per basket containing about 4,000 leaves germinates and keeps the leaf in good condition by maintaining the supply of moisture. Either the use of aquatic plants or any other new method that would be useful in the packing and preservation of betel leaf for export during summer would be welcomed.

Notes and Comments.

The B. Sc. (Ag). Degree Examination Results. The results of the B. Sc (Ag.) examination were out early this month, and we understand that 40 out of 48 candidates passed in Part I and 54 out of 59 in Part II. To the successful candidates we offer our hearty congratulations, and to the unlucky ones who missed getting through, our consolation that success in examinations is not everything in Life. To one and all of the students who are leaving us after three years' stay at the College, we send our very good wishes for the future. They are just on the threshold of life and these examinations are but the first steps in their career, whether they get employed under Government or other institutions or whether they take to private farming.

With the cry of unemployment everywhere about us, these agriculturally trained young men, should easily be the pioneers, in setting an example to other educated men, to take to following the plough as an honourable profession.

The Nitrogen Problem of the Soil. In the course of a lecture delivered under the auspices of the Association of Economic Biologists, Professor Sahasrabudde, Government Agricultural Chemist, Bombay, drew attention to the problem of nitrogen recuperation in the soils of the Bombay Presidency. Experiments at Bombay have shown that so long as lime and phosphoric acid are supplied in adequate quantities, the soils are able to get their own supply of Nitrogen, from the air. The easiest available source of lime and phosphoric acid in this country is, of course, bone, but this has to be powdered before application, which means cost. Professor Sahasrabudde's suggestion, therefore, to char the bones, after which it can be easily powdered without recourse to huge machinery, is well worth a trial by ryots not only in Bombay but in other parts of the country as well.

Indian Mangoes for His Majesty. We understand from a note in *The Hindu*, that six dozen mangoes of the 'Alfonso' variety have been shipped to England, packed under scientific conditions by the President of the Bombay Fruit-Growers' Association; and if on arrival they are found to be in good condition, they will be presented to His Majesty. The voyage of these pioneer mangoes will be followed with great interest by all Indians, chiefly mango dealers, for if the experiment is successful, it will open out yet another market for India's most delightful and nourishing fruit. It will also give an impetus to research on presentation of other fruits and vegetables, which, available for a song during the season, are not to be had on the market at other periods.

The Government Systematic Botanist. We learn with very great regret that Government have passed orders abolishing the post of the Government Systematic Botanist at the Agricultural College. One of the earliest sections in the Agricultural Department, it branched off during recent years, into several crop-breeding departments, many of which owe their original impulse and impetus to the traditions of this section. While as a measure of retrenchment, we believe, Government have decided to abolish the post, we earnestly trust, that when financial conditions improve, they will be pleased to revive this useful and necessary post.

ABSTRACTS

The Rothamsted Pachimeter.— Schofield, R. K. and Blair, G. W. S. (*Chemistry and Industry*, 1932, Vol. 51, p. 205).— A simple and rapid machine for determining the heaviness of soils is described. In essence, the method is to place a plastic mass of soil made into a cylinder of known length and diameter between two plates and roll it to and fro. A permanent lengthening occurs only when the stress on the cylinder is more than a critical value. The machine measures a single and definite property of the material, the shearing strength or yield value at its state of optimum workability. (T. R. S.)

Nitrogen Recuperation in the Soils of the Bombay Presidency. Part II.— Sahasrabuddhe D. L, and Ghatikar, B. H. (*Indian Jour. of Agr. Sci.*, 1931. Vol. 1, part VI, pp. 631–651). This is a continuation of previous work (*Mem. Dept, Agr., India, Chem. Series*, Vol. 8, Nos. 3, 5) wherein it was shown that the rate of nitrogen fixation and nitrification in the medium black soil of the Deccan, as experimented upon in the laboratory, was most active at 40° C and 30% moisture content, and that light, lime, intermittent drying and wetting and heating to 100° C, then cooling and adding water, favour an increase in nitrification. In the present paper, the experiments have been repeated with various typical soils of the Bombay presidency, e. g. (a) the medium black soil of the Deccan trap, on which *Jowar* (Sorghum) had been continuously grown without manures, (b) a Deccan River silt from a virgin land, which had been flooded once or twice every year during the rainy season, (c) a *Goradu* soil, the typical sandy soil of Gujarat, growing tobacco and manured with 1000 lbs. of farmyard manure, and (d) a laterite soil from Belgaum, heavily manured. The effect of the following treatments on the nitrogen recuperation of the above soils was examined:— (1) addition of lime as calcium carbonate, (2) addition of phosphatic substances, like super-phosphate, tricalcic phosphate and potassium phosphate, (3) organic matter, e. g. Cane-sugar, and (4) addition of alkali salts, e. g. sodium carbonate, sodium sulphate and sodium chloride. It was found that :— (1). In all the soils examined, lime increased the rate of nitrification, the beneficial effect being greatest in soils poorest in lime. (2) Phosphoric acid (in the proportion of 0·01 to 0·015 % on the dry soil) had a beneficial effect on nitrogen recuperation. Super-phosphate and tricalcic phosphate proved superior to di-potassium phosphate, except on the laterite soil, which was acidic and did not respond to additions of phosphorus. (3). Addition of carbohydrates like sugar, up to 2 %, to soils which already contained from 1·48 to 3·79 % organic matter, increased the total nitrogen fixed, the amount of increase being greatest with soils poorest in organic matter; the rate of nitrification is, however, adversely affected in the initial stages by addition of carbohydrates. (4). The alkali salts, sodium carbonate, sodium sulphate and sodium chloride, when added to the medium black soil of the Deccan, *Goradu* and laterite soils (0·01–0·2 % of sodium carbonate, 0·02–0·4 % of sodium sulphate or 0·03–0·6 % of sodium chloride) show a deleterious effect on the nitrogen recuperative power of these soils. Sodium carbonate is the most and sodium chloride the least harmful of the three. The alkali salts have the worst effect on the medium black soil, while their effect is the least on the laterite, which is an acidic soil. (5). In the case of river silt soil, however, the alkali salts in the quantities mentioned above, showed a stimulating effect on nitrogen recuperation. The river silt soil was also found to be easily stimulated by the addition of lime, phosphoric acid or organic matter. (C. N.)

Some Studies in respiration and other Metabolic activities in Berries of the Grape Vine. Jai Chand Luthra and Indar Singh Chima. (*Indian Jour. Agr. Sci.*, Vol. 1, pp. 695–714). The work was undertaken to discover if there was any

correlation between the intensity of respiration and the biochemical changes that occur in grape berries during the process of maturation. The *jaishi* and *tur* varieties of grape grown in the Botanical section of the Punjab Agricultural College, Lyallpur, were analysed for respiratory activity both *in situ* and in the detached condition, and also for the chemical composition, i.e., total solids, total reducing sugars, total titratable acids, nitrogen, water insoluble residue, cellulose and specific gravity, at different stages of maturity from the time when berries were 2 days old to the stage when they were completely mature (65 to 70 days). Correlations have been calculated between intensity of respiration and sugars, and between reducing sugars and total titratable acids. The following are some of the more important conclusions arrived at:— (1) The respiratory activity both in situ and of isolated branches, shows a continuous fall with ripening. It decreases from about 25 to 30 cc. carbon dioxide per 100 gm. berries per hour to about half the amount in 10 days, and to about one fourth the value in about 20 days, after which the value is almost constant for the next 40 days. There was no appreciable difference between the respiratory activity in day time and night time, except for a slight fall at night due to lower temperature. (2) The percentage of solids was high in the very early stages (11—12%), then showed a fall (7 to 8%) up to 4 weeks, followed by a steady recovery to the end (20—23% at the end of 70 days). (3) Starch could not be identified even at the early stages of berry formation. Reducing sugars showed a continued increase from about 1% at 2 days to about 94% of dry matter at maturity. (4) The acids present in grape (mostly, tartaric and malic) expressed as malic acid, show an accumulation in the early stages (up to about 30% at the end of 30 days), and then show a continuous decline (3—4% at the stage of maturity). (5) There was a steady decrease in nitrogen content during ripening (from 2·41% to 1·11%). (6) Water insoluble residue was found to be practically constant during the entire life cycle (4·7 to 3·4% on the weight of fresh berries). (7) Specific gravity showed a continual increase from 1·0190 to 1·0990. (8) The percentage of cellulose found by subtracting from the figures for water insoluble residue the corresponding amount of insoluble proteins, was also constant (2.661 to 2.016%). (9). The coefficient of correlation between sugars and respiratory activity was found to be significant and came to $-·52 \pm ·14$, which shows that increase in reducing sugars tends to lower the respiratory activity of the fruit. (10). The coefficient of correlation between reducing sugars and total titratable acids, was also significant, and came to— 0.78 ± 0.08 in the case of *jaishi* and -0.921 ± 0.03 in the case of *tur*, which shows that the berries during their early period of growth make use of both sugars and proteins. (C. N.)

Fertility in hybrids between New and Old World Cottons.—Harland, S. C. (*Nature*, 1932. Vol. 129, No 3254). The first hybrid between Asiatic and American cottons was recorded by Zaitzev. This was a cross between *G. herbaceum* (female) and *G. hirsutum* (male) but the resulting progeny proved completely sterile. Desai obtained a single plant of similar parentage to that described by Zaitzev, which was also sterile. Vycotski, more recently produced hybrids which were sterile, when self-pollinated, and when back-crossed to the parents Nakatomi also found sterility in the hybrid. Several thousand crosses were being made since 1925 between Asiatic and American cottons at the Cotton Research Station, Trinidad. Though using Asiatics as the female parent met with no success, two hybrids have been recently obtained by Dr. Harland with the New World Cotton as the mother (*G. barbadense* × *G. arboreum Var-Sanguinea*). Back crosses were successfully made to various types of *G. barbadense* and ultimately eight healthy plants were raised. These plants were again back-crossed with *G. barbadense* of various types in both directions. Three plants proved to be fertile and several seedlings from the second back-cross are being studied. The cytology of these hybrids is also under investigation. (R. S.)

Gleanings.

Spraying Orange Trees Alters Fruit.— "Oranges produced by trees sprayed with lead arsenate not only differ in chemical composition from normal oranges, but they have a considerably lower Vitamin-C content than oranges from trees not so sprayed, according to E. M. Nelson and H. H. Mottern of the Bureau of Chemistry and Soils. Doctor Nelson has completed a series of experiments which have demonstrated that besides causing a considerable loss of Vitamin-C, spraying with lead arsenate reduces the acidity of the juice and decreases the sucrose, with a corresponding increase in invert sugar. The principal orange-producing States have laws prohibiting the use of arsenical sprays on this crop. Spraying oranges with lead arsenate involves no danger of arsenic poisoning, according to the Bureau!"— A. E. B. in *Scientific American*, February 1932.

Cotton Picking Machinery Perfected — "A money saving machine which the Labour Department says will do in less than three hours the work that used to take one man 77 hours, is ready to take its place in the cotton fields. Mechanical experts of agricultural experiment stations declare that practical perfection of cotton harvesting machinery has arrived. Not only has the machine for picking arrived, but the cotton gin has been more fully perfected to prevent loss of quality by machine picking. The department said that the labour saving represented by the new machine is a net gain for the cotton farmer. 'The perfected machinery', says the Labour Department's announcement, 'is the result of an early idea of progressive cotton farmers who had experimented with gathering fallen bolls with a horse drag, at the same time stripping from the plant the bolls that had not fallen ..... The idea was taken up by other farmers, and the experts of the agriculture experiment stations got to work on it. First a rude sled was constructed with a V-shaped slot for catching the stalks and stripping off the bolls. The bolls were worked backward by the forward motion of the sled into a wooden box. The first cotton sleds stripped only one row at a time, but were soon widened to cover two, three and finally four or more rows."— *Scientific American*, February, 1932.

Isolation of Vitamin A— "Following closely on the announcement of the probable preparation of Vitamin D by several independent workers (*Nature*, Jan. 9, p. 5), come two announcements of the isolation of a substance which *prima facie* appears to be the long-sought Vitamin A. In a paper published in the issue of *Helvetica Chimica Acta* for December 1931, Prof. P. Karrer of the University of Zurich, together with R. Morf and K. Schopp describe the isolation and purification from the unsaponifiable fraction of the liver oil of the skipper (*Scembresox saurus*) of an alcohol having the formula $C_{20}H_{30}O$ or $C_{21}H_{33}O$ optically inactive, and possessing the molecular weight 300—320. Esters of acetic and p-nitrobenzoic acids were prepared, and the alcohol gave geronic acid on oxidation with ozone. The same substance was obtained by a special method from the liver oil of the halibut (*Hippoglossus hippoglossus*). In an address on "Recent Progress in the Chemical Study of Vitamins," given to the Londan section of the Society of Chemical Industry on Jan. 4, Prof. J. C. Drummond stated that he, in collaboration with Prof. I. M. Heilbron and Dr. R. A. Morton, had succeeded in isolating, by a process of fractional distillation, a very potent fraction from the unsaponifiable residue of the liver oil of the halibut. The substance is a heavy, viscid oil of a slightly yellow colour; it is an alcohol, and its vitamin potency is of the same order as that of the recently discovered 'calciferol'. Sufficient work has not been done to enable us to say that the substance is pure Vitamin A, but it seems very probable that its purity is approximately ninety per cent.— (*Nature*, Jan. 16, 1932, p. 88).

Vitamin B and Phytase.— "Since Teru-Uchi has shown that experimental beri-beri of pigeons (*avitaminosis B*) is caused by the action of a toxic substance, orizotoxin, extractable from polished rice, and Iwata has found that lysocitin, a substance formed from lecithin by the action of certain enzymes, occurs in polished rice, the possibility of a relationship between lysocitin and orizotoxin arises. A series of experiments made by Cuboni and described in the *Rendiconti of the Reale Instuto Lombardo di Scienze e Lettere.* (Vol. 64, parts 11–15, 1931) shows that all the symptoms of beri-beri may be reproduced in chickens by injections of orizotoxin, whereas injection of lysocitin has no such effect. Various analogies in behaviour between phytase—which, as Belfanti and Contardi showed, prevents and cures beri-beri—and Vitamin B are pointed out, and the conclusion is drawn that these two substances are certainly closely related and probably identical. Further similarity between phytase and Vitamin B is revealed by experiments—described in the same issue—carried ont by Arnaudi, who finds that the growth of yeast and certain other micro-organisms is accelerated in the same way by the two substances." (*Nature*, Jan. 16, 1932).

The Chemist and the Plant Breeder. "Success in the elimination of an adverse quality or factor from a plant has been attained in Germany in several instances, particularly that of the *lupin*. This plant grows easily on light soils and produces a considerable amount of protein, but the presence of bitter poisonous alkaloids in the green stalks and leaves, as well as in the seeds, has hitherto restricted its use as a fodder plant. Occasional sweet plants, free from alkaloids, has been discovered as the result of testing individually more than a million and a half lupid plants, use being made of a very simple precipitation reaction, which has enabled many thousand single plants to be examined in a day. Fortunately, these sweet plants are found to breed true, and now, in consequence, enough seed has been collected to ensure that in about two years' time large field crops of edible sweet lupin can be grown on the light sandy soils, and it is hoped that these will prove most valuable fodder crops. Working on similar lines, it has been possible to obtain a variety of *Melilotus albus*, free from objectionable coumarin; this will be another useful forage plant.

Plant breeders have even progressed so far that varieties of *tobacco* have been bred which are free from nicotine, but otherwise highly aromatic and satisfactory to smoke. Progress in work of this kind is immensely facilitated by the availability of quick chemical methods of testing for very small quantities; great strides are being made in our technique of handling very small quantities, and it is undoubtedly one which the intending bio-chemist should master; the "emulson" test for plant glycosides, and the picrate paper test for hydrogen cyanide are examples which come to mind. There are many heritable factors in plants which have a chemical basis of which we shall some day understand the nature."— *Chemistry and Industry*, No. 20, 1931, Extracted from *Tropical Agriculture*. March, 1932.

The Cow and the Scientist. "How is milk made? This is one of the universl mysteries of science, according to Sir William Dampier, F. R. S., who reviews in the Empire Marketing Board's latest report, the extent and objects of dairy research. Scientists have still to discover how cows turn the raw material—grass—into the finished product of which we make such good use .....Although the process of milk manufacture remains the cow's trade secret, it does not possess that great virtue of mass production—the ability to turn out an exactly standardised article. Charts worked out at the National Institute for Research in Dairying at Reading show that the composition of the same cow's milk varies from day to day and even from morning to night. This alteration in quality in turn affects the butter or cheese. More research is needed on the factors such as feed, breed and climate, which may cause these variations. Further research is

needed most urgently in the following fields :— Improvement of pastures by plant breeding and by better management— e.g. frequent cutting and intensive grazing; the effect of differences in rationing on the composition of milk; the inheritance of high milk-yielding qualities in cattle; the physiology of milk secretion; the inoculation of cattle against tuberculosis; the survival of disease germs in dried and condensed milk; the ripening of cheese and the effect of storage conditions on butter and cheese and the economics of the industry. Science has already achieved results which are of direct interest to Australians. In the field of nutrition, for instance, the most recent advance is the discovery that young fresh grass has a high protein content which makes it comparable with expensive concentrates, such as linseed cake "Young grass is specially efficacious in increasing the yield of milk," Sir William Dampier says, "It is now, or soon will be, available in large quantities in the form of ensilage or dried cake, and more experiments on its influence on the quantity or quality of milk should be made as quickly as possible." The work on the mineral needs of cattle, which natural pastures often fail to supply, is already well known in Australia.—(*Queensland Agricultural Journal*, March 1932.)

Agricultural Industry. The fall in the price of agricultural produce in all countries has resulted in a depression, so long continued and so intense, that it is certain to lead to far-reaching changes in agriculture itself. One of these is now becoming evident. Agriculture is rapidly becomming an industry dependent on the market, and is ceasing to be a mode of living for the great mass of people engaged in it. Both the farmer and the peasant sell most of what they produce and buy most of what they require. They are in business and the market dominates them. This fact must be kept steadily in view in considering the future development of the industry. Up to the present, the application of science to agriculture has been concentrated on the discovery of improvements which can be applied within the existing structure of the industry. This no longer suffices. What is now needed are fresh approaches to the problems of production and distribution. The frame work of the industry itself must now be added to the list of subjects for investigation, so that new and novel means can be found to increase the output per unit of capital and per unit of labour. One such experiment in which the small holdings of the peasant have been converted into large-scale communal farms, is now in progress in Russia. Proposals for experiments in new methods of farming have recently been before our own Parliament, but have had to be dropped for the present for reasons connected with the general financial position. Another obvious field of experiment lies in the educational domain, in extending the area from which the industry is recruited so that new ideas and new points of view may rapidly gain adherents.

An Opportunity in India. An interesting experiment in agricultural education and training is now being undertaken in India by Cap. J. W. Petavel, at Kamshet, near Poona. An area of five hundred acres of suitable land, close to the railway line between Bombay and Poona, in a good climate and provided with facilities for the development of irrigation, has been secured for trying out a novel method of preparing the sons of the Indian intelligentsia for a career on the land. The project received the active support of the late Sir Ashutosh Mukherji, vice-chancellor of the University of Calcutta. The idea underlying the scheme is the creation of an educational and training colony in which practical training in agriculture can be combined with ordinary schooling. The boys will be prepared for the usual examinations, but will take part in the growing of crops and in the care of animals. This will be possible by reducing the time devoted to study by two hours daily, so as to make room for three hours' productive work in the fields. An effort is being made to collect the best boys possible and not to confine recruitment to any particualr class. It is hoped in

this way, to attract to the land a number of youths who otherwise would merely increase the army of unemployed university graduates, now such an acute problem in India. So far, all efforts in this direction which have been made in the past have failed. Great changes in the outlook of educated India are, however, now taking place. The dislike of manual work which, a quarter of a century ago, used to be such a marked characteristic of the higher castes is rapidly disappearing. There is at the moment nothing impossible in the idea of utilising large numbers of the new generation for the development of agriculture—India's greatest industry. All that is needed are successful experiments, followed in due course by effective publicity.—(*Nature*. February 6, 1932.)

Correspondence.

Mr. E. S. Viswanathan writes from Pallavaram :—

Will you or any of your readers enlighten me on the following points :—

(i) On P. 9 of the *Villager's Calendar*, 1932, the expression "Propping plantain bunches with single bamboos" occurs. Again on P. 13, referring to sugarcane planting the expressions "eye to eye" and "end to end" are used What do these expressions mean?

(ii) In the September 1931 (Vol. XIX No. 9) number of *Madras Agricultural Journal*, ammonium sulphate is recommended as a weed-killer. Does this chemical produce any injurious after-effects?

Answer. (i) The method of propping plantain referred to involves the support of an individual bunch on a single bamboo which is done by tying the stalk to the bamboo.

The expression "eye to eye" planting refers to the method in which setts are laid in a line. and in such a manner that the eyes or buds of one lies just below those of another, i. e. one sett overlaps another. In contrast "end to end" planting is the laying down of setts in a line with one end just below the other.

(ii) Ordinarily there will be no injurious after-effects if ammonium sulphate is used as a Weed-Killer. In soils poor in lime, after-effects are likely to appear and if and when this occurs it may be corrected by application of chalk and organic matter. It must however be noted that the use of this method in eradicating large areas of weeds is very expensive. In such cases cultural operations are preferable.

College News & Notes.

University Examinations. The students of class II and III had a busy time with their examinations. The university examinations commenced with Part I, theory, on 4th April and went on until the last week of the month. The Board of Examiners met on 28th to pass the results which are published elsewhere in this issue.

Students' Activities. The College closed for the summer vacation on 31st March. As is usual, towards the end of each academic year, there were a number of social gatherings, the wards entertaining the tutors and the tutors in turn entertaining their wards.

The students had collected some amount from amongst themselves and from the tutors and lecturers in connection with the conduct of the College Day sports. As the amount had not been fully utilised for the sports, with the balance available they arranged for a dinner in the students' hostel on the 28th March to which, the Principal, tutors, lecturers and games coaches had been invited. At the conclusion of the dinner toasts were proposed for the Students' Union and the final year students.

Visitors. In connection with the university examinations a number of visitors were in our midst for short periods during the month. Among them may be mentioned Mr. I. Raman Menon, Retired Superintendent of Agriculture, Cochin State, Dr. C. J. George of the Madras Fisheries Department and formerly an officer of the Madras Agricultural Department, Mr. V. Krishnamoorthy Aiyar of the Madras Veterinary College, Mr. Ramachandra Aiyar of the Industries Department, Professor D. L. Sahasrabuddhe of the Bombay Department of Agriculture, and Rao Bahadur D. Ananda Rao, Headquarters Deputy Director of Agriculture.

Mr. M. Vydianatha Aiyar, Statistician to the Imperial Council of Agricultural Research, paid a short visit to the Institute to discuss with the Agricultural Chemist the report of the special officer regarding the manurial experiments conducted at the different agricultural research stations of Madras.

Mr. S. V. Ramamurti, I.C.S., the Director of Agriculture, paid a visit to the Institute towards the end of the month, and it is understood he discussed with the heads of sections the question of preparing a cinema film with a view to make the research work carried on at the Institute better known to the intelligentia of the province.

Farewell Address to Mr. T. V. Rajagopalacharya. Before the closing of the College for the summer holidays the students arranged for a special meeting on 30th March to present a farewell address to Rao Sahib T. V. Rajagopalacharya, Vice-Principal of the College who is to retire from service shortly. Mr. Tadulingam, the Principal, presided. The students presented him with an address expressing their deep sense of gratitude for all he had done to them as their Professor of Agriculture, and wishing him a well earned rest and a long life to enjoy the same. Although the function had been got up mainly by the students, a number of friends of Mr. Achary who were present at the meeting joined the students in paying their tributes to Mr. Achariar and making special mention of several of his characteristics. Mr. Achary in reply thanked the students for their address and his friends who had spoken that evening. He briefly outlined his career in the Department which had not been happy right through and stated that if his students wished to emulate him they might keep in mind the two qualities, optimism and contentment, which have been his two guiding principles in life. With the distribution of *pan-supari* the meeting terminated.

Scout Masters' training camp. There was a scout masters' training-camp for the Coimbatore district for about ten days between 11th and 20th of April. The camp met at a garden close to the Paddy Breeding Station and there were about 30 people who had come for the training, mostly from the different parts of this district and a few from other districts as well. Mr. Rathnasabapathy, the organising secretary of the scout movement in Madras, conducted the classes personally. One of the afternoons during the camp had been set apart as a visitors' day and special invitations had been sent to a number of people in the town. The visitors were shown round the camp and there was a display of the scout games in their presence. The camp broke up with a dinner on the 20th.

After the camp broke up the local boy scouts who were all anxious to experience camp life were taken to the camp by the scout master Mr. M. R. Balakrishnan and they all enjoyed a two days' stay there.

Association of Economic Biologists. Under the auspices of the association Professor D. L. Sahasrabuddhe of Poona delivered an interesting lecture on "The Nitrogen Problem of the Bombay soils." In the course of his lecture he explained the existence of a nitrogen cycle, according to which there was a gradual rise in the amount of nitrogen held in the soil up to a certain limit, followed by a gradual loss of the same. From his experience of the dry soils of the Bombay presidency, the maximum quantity of nitrogen which the soil was able to retain was dependent

on the amount of moisture, lime and phosphoric acid contained in the soil. Even with regard to the lime and moisture contents of the soil, he stated, there was a limit beyond which they would not augment the fixation of nitrogen. The best way of maintaining or increasing the lime and phosphoric acid contents of the Bombay soils was an application of bone meal. Though raw bone was cheap and easy to collect in the villages, by the time it came to the cultivator as bone meal, it becomes too expensive for the poor cultivator to afford to buy it. Investigations were therefore undertaken to get the bones in a usable form in as cheap a manner as possible. It appears that if raw bone is converted into charred bone by burning it with twigs, the resultant product being friable can be easily powdered, entirely dispensing with the mechanical disintegrators. This charring has been found to be so cheap that even the portions of nitrogen and organic matter contained in the bone that get lost by burning can be made good by the addition of a small quantity of cake at a small cost. The charred bones thus used cost the cultivator only half or even less than what he would have to spend if he went in for bone meal. This practice is now being advocated by the Bombay Department. The cultivator is also being advised to compost all the available organic waste matter of the village and use it profitably for manuring his dry lands. Thus the Bombay results, so far as the dry lands are concerned, indicate that there is no necessity to go in for any chemical nitrogenous fertiliser. The application of organic matter helps the soil to retain moisture and the charred bones supply the required amount of lime and phosphoric acid. The soils containing enough of these ingredients are able to form and retain the necessary amount of nitrogen for the dry crops grown in them. Even as regards the application of chemical nitrogenous fertilisers to irrigated and wet lands, unless the soils contained the optimum amount of organic matter, lime and phospheric acid, it would not pay to go in for them. So the motto, in the words of the lecturer, would appear to be "mind your lime and phosphoric acid contents of the soil and the nitrogen will take care of itself".

At the conclusion of the lecture there was an interesting discussion in which Messrs. B. V. Nath, Dr. Seshadri, T. V. Rajagopala Achary, S. R. Sreenivasan and K. Ramiah took part. (K. R.)

Sampson Memorial Fund.

Mr. K. Gopalakrishna Raju, Honorary Secretary of the Fund, writes:—

The attention of the subscribers to the Fund is invited to Page 558 of the October 1930 issue of the *Madras Agricultural Journal*, which contains a statement of the accounts.

2. Out of a balance of Rs. 465—1—0 deposited with the District Urban Bank, Coimbatore, after meeting the expenses connected with the unveiling of the portrait of Mr. Sampson, a sum of Rs. 5—1—0 was expended towards postage and printing charges of the statement of accounts, which was sent to every subscriber. The balance amount of Rs. 460 together with interest up to 27th July 1931, amounting in all to Rs. 481—11—0, was sent direct by the District Urban Bank to the Accountant-General, Madras, for investment of the amount in Government securities.

3. The Government were pleased to contribute a sum of Rs. 230 towards the Fund. The total sum of Rs. 711—11—0 to the credit of the Fund has been vested in the Treasurer of Charitable Endowments as detailed below: 1. 3½ per cent. Government Securities for Rs. 1,100—0—0 2. 3 per cent. Government Securities for Rs. 100—0—0 and 3. cash Rs. 3—7—8.

4. The Government order on the Sampson Memorial Prize Fund scheme and the adminstration of the securities and money vested in the Treasurer of Charitable Endowments has been published in Page 1373, Part I of the *Fort St George*

Gazette, dated 20th October 1931. The annual interest that will accrue from the investment will be about Rs. 41—8—0, which will be the value of the prize. The prize (gold medal) will be awarded every year from 1932 onwards to a student of the Agricultural College, Coimbatore, who obtains the highest number of marks in the subject of Botany in Part II of the examination for the B. Sc. Ag. Degree and qualifies himself for that degree at first appearance both in parts I and II.

Weather Review (APRIL, 1932)

RAINFALL DATA

Division	Station	Actual for month	Departure from normal	Total since January 1st	Division	Station	Actual for month	Departure from normal	Total since January 1st
Circars	Gopalpore	0	−0·8	1·4	South	Negapatam	3·1	+2·5	6.0
	Calingapatam	0.5	−0·7	1·1		Madura	1·8	−0·2	2·7
	Vizagapatam	0·3	−0·5	1 8		Koilpatti*	5·0	+2·0	9 5
	Anakapalli*	2·59	+1·1	5·2		Pamban	3·2	+1·6	3 4
	Samalkota*	0·2	−0·4	1·2		Palamkottah	1·3	−1·2	3 4
	Cocanada	0·1	−0·5	0·6					
	Masulipatam	0	−0·6	2·9					
Ceded Dists.	Kurnool	0	−0·6	0·8	West Coast	Trivandrum	2·5	−1·9	5 1
	Bellary	0·2	−0·6	0·2		Cochin	2·5	−2·2	3 ?
	Nandyal*	0·2	−0·1	0·4		Calicut	2·0	−1·3	2·)
	Hagari*	0·6	+0·2	1·2		Taliparamba*	0·9	−1·7	0·)
	Cuddapah	0	−0·4	0·1		Mangalore	0·4	−0·9	0 4
Carnatic	Nellore	1·5	+1·1	2·3	Mysore and Coorg Hills.	Bangalore	0·3	−1·0	3·9
	Madras.	0·6	+0·1	1·3		Mysore	1·7	−0·7	1 8
	Cuddalore	2·8	+2·2	3·5		Mercara	1·4	−1·3	2·9
	Palur*	3·6	+2 6	3·8					
Central	Vellore	0·2	−0·7	0·8		Kodaikanal	4·8	+0·6	·4
	Salem	2·2	+0·4	4·5		Coonoor	2·7	...	3 3
	Coimbatore	2·8	+1.4	5·5		Nanjanad*	5·2	+1·8	5 ?
	Coimbatore Res. Inst.*	2·8	+0 9	5·1		Kallar*	2·5	...	5 4
	Hosur Cattle Farm	4·1	+3·4	5·9		Ootakamund*	1·1	−2·6	1·3
	Trichinopoly	1·6	...	2·7					

N. B. * Meteorological Stations of the Agricultural Department.

Summary of General weather conditions.— The weather was generally dry and fine over the area till the 9th when the conditions in the centre of the Bay became unsettled and the unsettled weather persisted till the 18th when conditions became more normal. This unsettled weather induced a flow of moist sea winds over the Peninsula and thunderstorms occurred in Malabar, and in the southern and central districts and were nearly general between the 13th and 15th extending as far north as Hyderabad (Deccan). Weather was fine thereafter with the prevailing winds blowing into the "Low" over the Deccan which was the area of high temperatures. Rainfall was above normal in the Carnatic, Central districts and in parts of the South and the Hills, and was in defect elsewhere. Hosur Cattle Farm reported a fall of 2·82 inches in 24 hours. Temperature was generally below normal, the defect being most marked in the case of the Maxima during the period of unsettled weather. Nellore reported a maximum of 109° on the 18th and Cuddapah and Masulipatam 108° on the 8th, 19th and 17th respectively.

Report for the Research Institute Observatory: No. 4 /32.

Absolute Maximum in shade	...	...	98·1
Absolute minimum in shade	...	...	70·0
Mean maximum in shade	...	...	94·0
Mean minimum in shade	...	...	72·7
Total rainfall in month	...	...	2·75 inches
Mean rainfall for April	...	...	1·84 „
Departure from normal	...	...	+0·91
Number of rainy days	...	...	4
Mean daily wind velocity	...	...	1·3 M. P. H.
Mean 8 Hours wind velocity	...	...	0·4
Mean Humidity at 8 Hours.	...	...	74 2 %
Total Hours of bright sunshine	...	...	277·8
Mean daily hours of bright sunshine		...	9·3

Summary of weather conditions. The weather was influenced by the unsettled weather in the Bay and thunderstorms were frequent during the month. A thunderstorm gave 1·77 inches of rain on the 12th evening accompanied by a squall of the line squall type Temperature was moderately high during the month and reached a maximum of 98·1° on the 8th (P. V. R. and P. K. R. M.)

Departmental Notifications.

I Circle.— Transfer. A. Gopalakrishnayya Naidu, F. M. Hosur posted to Peddapuram Sub-circle as A. D. **II Circle.** V. V. S, Varadarajam l. a. p. granted for 29 days from 5—5—32. **III Circle.** One month's l, a. p. granted to K. Hanumantha Rao A. A. D. Rajampet, cancelled. K. Ramanatha Iyer, A. D. extension of three months' leave i. e. 29 days l. a p. and 2 months and 1 day half average pay on M. C. in continuation of leave already granted. **IV. Circle.** T. K. Mukundan (re-instated) is to relieve N. V. Kalyanasundaram Iyer, who is to work under A. D. Cuddalore. V. Kumaraswami, A. D. Tiruttani, l. a. p. for one month from 23—4—32 and S. Rama Rao, A. D. Chittoor will be in additional charge of Tiruttani. K. V. Natesa Iyer, A. D. Kallakuruchi, l. a. p. for 14 days from 5—5—32. P. S. Venkatasubramanian, F. M. Kalahasti, l. a. p. for one month from 4—5—32 or date of relief. **V. Circle.** K. rinivasachary A. D, Pattukottai, l. a. p. for 20 days from 4—5—'32. **VIII Circle.** *Postings.* A. K. Ramasubba Iyer, A. D. Bhavani to be A. D. Annur. K. H. Subbramania Iyer, F. M. Hosur to undergo training under A. D. Coimbatore. *G. E's Office.* T. S Alwar Iyangar, Senior Artist, extension of l. a. p. for one month from 1—5—'32 *Oil Seeds Specialist's Office.* G. V. Narayana, Assistant, G. S. B. section joined duty in the O. S. S's section as assistant on 30—4—'32. *Cotton Section.* R. Govindarama Iyer, F. M. l. a. p. for 24 days from 30—3—'32 with permission to prefix the Easter Holidays and extension of l. a. p. for 8 days. *M. S. Section.* P. V. Hariharan, Assistant l. a. p. for 15 days from 26—4—'32. *Paddy Section.* M. Ramaswamy Pillai, S A. l. a. p. for one month from 3—5—'32. *D. A's Office Orders. Transfers.* M. B. Venkatanarasinga Rao, Assistant, A. R. S. Maruter to the Rice Research Station, Berhampore. K. B. Viswanathan, Assistant, A. R. S. Maruter to the R. R S. Berhampore. M. Narasimhan, Assistant Cotton Section to the A. R. S. Maruter, P. K. Nambiar. P. K. Narayana Nambiar, A. D. Annur to work in the Laccadive Islands this year. K. H. Subramania Iyer, F. M. Hosur to VIII Circle. John A. Muliyil l. a. p. for 1½ months from 1-5-32. G. K. Chidambaram, Assistant Chemistry Section, l. a. p. for one month from 26-4-32. S. Rajaratnam Chetty, Assistant whose officiating appointment terminates on 25th April '32, will continue to officiate vice G. K. Chidambaram. C. Rangaswamy Iyangar, Lower subordinate, promoted to upper subordinate V grade in the Agricultural Section

from 1-5-32. R. Anandapadmanabhan, probationer, will officiate from 1-5-32 vice C. V. Seshacharya on other duty. The following posts in the System Botany Section Research Institute, Coimbatore, have been abolished as a measure of retrenchment. The post of Systematic Botanist, 1 post of upper Sub-ordinate 2 posts of Lower subordinates, 1 post of Artist and 1 post of a clerk typist. The staff retained for work in the Botany Section, will work under the Principal. The staff in the Systematic Botany Section, after giving effect to the Government order will be as follows: 1 Upper sub ordinate (on Rs. 250/-) K. Cherian Jacob. 1 Lower sub-ordinate (I grade Rs. 120) S. Ramaswamy Raju 1 Lower subordinate V grade Rs. 45—3—75. Name of the Sub asst. will be communicated shortly. G. Venkatanarayana posted as Assistant Cotton Section, but will work under the O. S. S; R. Krishnamurthi, Assistant, Cotton Section will officiate vice R. Balasubramanian, Herbaccum Botanist, I. C. C. K. Kumaraswamy Chetty, Asst. Cotton Section will officiate vice M. B. Venkatanarasinga Rao, Asst. Paddy Section. M. Ratnavelu, Sub-assistant, G. S. B's section to be A. F. M. Central Farm. As regards T. R. Naganatha Iyer, J. David, sub assts. M. Singara Royan Artist, D. B. Ngaraja Rao, clerk-typist, orders will be issued shortly.

Latest Notifications: Gazette: Mr. T. V. Rajagopalacharya, Vice-principal, Agricultural College, Coimbatore, granted leave for one month and 14 days from 2nd May 1932; Mr. V. Muthusami Ayyar, Offg. Lecturer, to hold additional charge of the current duties of the post. Mr. S. Dharmalingam Mudaliar, Paddy Asst. to officiate as Superintendent, Agricultural Station, Pattambi. Mr. G. N. Rangaswami Ayyangar, Millets Specialist, granted leave for 2 months from 29—5—32.

Non-Gazetted. I Circle. *Transfer.* D. Hanumantha Rao, A. D. Ramachandrapuram posted to Razole, A. Rammohan Rao posted to Tadepalligudem. **II Circle.** P. Sudarsanam, A. D. l. a. p. for 20 days from 10—5—32, T. Paramanandam, A. D. l. a. p. for 27 days from 16—5—32. *Transfers.* B. V. Ramana. A. A. D. posted to Guntur, V. V. S. Varadharajan, A. D. Bezwada as F. M. A. R. S. Guntur. P. Satyanarayana, A. A. D. Kavali to Gurazala, D. Panakal Rao, A. D. Gurazala to Bezwada sub circle. T. Paramanandham, A. D. Guntur as F. M. A. R. S Guntur to be in charge of the Farm. J. Suryanarayana, F. M. A. R. S. Guntur as A. D. Kavali. **III Circle.** M. Vaidyanathan, F. M. Hagari. l. a. p. for 1½ months from 15—5—32. S. Muthuswamy, A. D. Kudligi l. a. p. for one month from 11—5—32. **V Circle** S. Mahadeva Iyer, A. D. Aiyalur l. a. p. for 3 weeks from 4—5—32. **VII Circle** K. V. Shenai A. D. Puthur l. a. p. for 15 days from 16—5—32. **Live Stock Section.** M. C. Menon F. M. l. a. p. for 16 days from 18—5—32. **P. S's Section.** K. Hanumanther Rao, Asst. l. a. p. for 16 days from 16-5-32. **M. S's Section.** U. Achutha Warior Asst., l. a. p. for 15 days from 16—5—32. **Cotton Section.** R. Krishnamurthi, Asst. l. a. p. for 20 days from 9—5—32, L. Neelakantan, Asst. l. a. p. for 20 days from 23—5—32. **O. S. S.'s Section.** V. K. Kunhunni Nambiar, F. M. Nileshwar, II Station, l. a. p. for 2 months from 3—5—32. P. K. Kannan Nambiar, A. A. D. Kasargod posted to A. R. S. Nileshwar, II Station. **VIII Circle.** P. V. Raghavendra Rao, A. A. D., Dharapuram, l. a. p. for 2 months and 9 days from 7—6—32 preparatory to retirement from 16—8—32. **D. A's Office Orders**— The Period of absence of K. T. Benjamin from 19—1—31 to 28—11—31 will be treated as leave on half average pay, and the period from 29—11—31 to 21—4—32, as extraordinary leave. P. Vishnu Somayajulu, Asst, Bycology Section posted to I Circle at Anakapalli & C. S. Gopalaswamy Rao Asst to II Circle at Guntur. *Transfers.* M, B, Venkata Narasinga Rao and K. B. Viswanathan Assts. Maruteru, to be temporary Assts, Rice Research Station, Berhampur. M. Narasimham, Asst, C. B. S. Coimbatore, to be assts. A. R. S. Maruteru. K. Kumaraswamy Chetty, offg asst, Paddy Breeding station, Coimbatore, will work in the cotton Breeding Station, Coimbatore. Ghulam Ahmad, offg. Asst. C. B. S. Coimbatore as upper subordinate, Agrl. Section, Rajahmundry. A. Ramadass, Agrl. Section IV Circle to Science Section, Asst. Cotton Breeding Station,

Coimbatore. D. Shanmuga Sundaram to the Agrl. Section VI Circle. V. Tirumal Rao Asst, I Circle will continue to work in the I Circle with head quarters at Anakapalle. P. S. Krishnamurti Asst. Coimbatore to II Circle with head quarters at Guntur. M. S. Subbayya Asst. Coimbatore posted to work in the Districts comprising V & VI Circles with head quarters at Koilpatti. P. S. Narayanaswamy, Asst, Coimbatore to the VII Circle with head quarters at Taliparamba. C. S. Balasubramaniam offg. Asst. Coimbatore to III with head quarters at Bellary. P. Narayanan Nair F. M. Central Farm transferred to VIII Circle as A. D. Dharapuram.

B. Sc (Ag) Examination 1932—Results.

The following candidates have passed Part I of the B. Sc (Ag) Examinations 1932:—

1. Adinarayana Rao, K.
2. Bhavani Sankar Rao, M.
3. Dhanapandian, D. T.
4. Devasigamony, T.
5. Ekambaram, C.
6. Hanumantha Rao, D. C.
7. Krishna Menon, K. M.
8. Krishnamurthi, N. H. V.
9. Krishnaswami,
10. Lakshmanan, S.
11. Mahadevan, G.
12. Mohammed Abdul Jaleel.
13. Mohammed Obeidullah Shah.
14. Nagarajan, K. R.
15. Narayana Menon, B. G.
16. Narayanan, K. M.
17. Narayaniah, Y. V.
18. Ponniah, B. W. X.
19. Raghunatha Reddy, K.
20. Rajeswara Gupta.
21. Rama Reddi, M.
22. Seshadri Iyengar, T. V.
23. Srinivasa Rao, D.
24. Srinivasa Raghavacharlu, V.
25. Sri Rama Reddi, N.
26. Sundararajan, K.
27. Varadarajan, S.
28. Venkataswami, Y.
29. Venkatamuniappa Chetty, C.
30. Venkatarama Reddy, T.
31. Anantha Rama Panda.
32. Purushothamacharyalu, A. V.
33. Lakshmanacharya, C.
34. Seshagiri Rao, U.
35. Dakshinamurthi, T. S.
36. Daniel, F. L. T.
37. Ranga Rao, J. P. V.
38. Konda Reddi, G.
39. Subba Reddi, M.
40. Kunhi Raman Kidavu.

The following have passed Part I, with Reference in Subjects:—

1. Gideon Ayyadurai (Engineering).
2. Gopalakrishnan, P. (Botany).
3. Sathyanarayana, K. V. S. (Chemistry).
4. Sitharama Raju, M. (Entomology).
5. Thirumal Rao, W. C. (Chemistry).
6. Venkataswami, K. (Chemistry).

The following have passed Part II of the Examinations:—

1. Abbul Samad.
2. Ananthan, S.
3. Ananthaprabhu, N.
4. Balanna, G.
5. Balasubramanian, T. S
6. Bhushanam. K.
7. Ganesamurthi, K.
8. Govinda Kurup, K.
9. Joga Rao, P V.
10. Kondaswamy, K.
11. Krishnamurthi, V. G.
12. Krishnamurthi Rao, S.
13. Krishnan, D.
14. Krishnan, C. S.
15. Muthuswami, P. N.
16. Narasinga Rao, C.
17. Rangaswami, K.
18. Rajagopalan, V. V,

19. Sambasiva Rao, I.
20. Sethuramalingam, M.
21. Shanmugasundaram, A.
22. Sobhanadri, N.
23. Soundira Rajan, A. R.
24. Subbarayan, T. R.
25. Subramanian, L.
26. Subramania Chetty, M
27. Suryanarayana, R.
28. Swaminathan, A. S
29. Tejapya Shetty, K.
30. Udhobo Patnaik,
31. Vaidyanathan, J.
32. Vedanthachari, K.
33. Venkatadri Reddi, V.
34. Venkata Ramanappa, S.
35. Viranna, N.
36. Krishnamurthi, S.
37. Narahari, C.
38. Dasa Rao, C. J.
39. Krishnasami, P.
40. Sankaran Unni Wariyar, T.
41. Adisesha Reddy, A. B.
42. Narasimham, K. M.
43. Ponnappa, N. G,
44. Raghava Menon, P.
45. Narayanan, O. K.
46. Brahmeswara Sarma, G,
47. Syed Mohammed, P. P,
48. Muthugopalan, K. R.
49. Balakrishnan, K,
50. Ramaswami, R,
51. Deju Shetty. K,
52. Venkatachalam, M,
53. Govindan Nair, K. V,
54. Kripadanam, C. H.

UNIVERSITY OF MADRAS

B. Sc. Ag. Degree Examination Question Papers 1932.

PART I

1. AGRICULTURAL ENGINEERING

(Monday, 4th April. 7 A. M. to 10 A. M.)

Six Questions are to be answered. Question 6 is Compulsory.

1. (*a*) Explain the terms—horse-power, 'creeping' of belts.

(*b*) Determine the width of belt for transmitting 10 h. p. to a pulley 12 in. diam., so that the greatest tension may not exceed 40 lb. per in. of the width of belt, when the pulley makes 1, 500 r. p. m. Assume that the weight of the belt per sq. ft. is 1·5 lb., and the coefficient of friction is 0·25.

2. (*a*) How do you distinguish steel, wrought iron, and cast iron?

(*b*) Specify the nature of metal ordinarily employed for the following parts, with reasons:—(i) anvils, (ii) hand hammer, (iii) underground pipe-line, (iv) pickaxe, (v) connecting rod, (vi) big-end bearings, (vii) piston rings, and (viii) plunger rod of a piston pump.

3. (*a*) Explain the terms—engine efficiency, water efficiency.

(*b*) Neglecting frictional losses, find the speed of a centrifugal pump having radial vanes for lifting water to a height of 20 ft., the outside diameter of the vanes being 18 in.

4. (*a*) Explain the term—'bonding' of a masonry structure. What are the objects gained by 'bonding' in stone masonry?

(*b*) What are the general principles to be observed in the building of stone masonry?

5. A Mangalore tiled roof, 30 ft. span, 7 ft. 6 in. rise, weighing 10 lb. per sq. ft., is carried on common rafters 2 ft. 3 in. apart, supported by king-post trusses. Determine the sections for common and hip rafters.

6. What will be the discharge per minute from a large tank 25 ft. deep through a short pipe 2 in. diam. leading from and flush with the bottom of the tank? What difference in discharge would it make if the pipe were to project 6 in. into the tank?

7. Make neat *freehand* sketches of a double-panelled door 6 ft. 6 in. × 3 ft. 6 in., indicating how this is to be fixed to a brick wall 1 ft. 6 in. thick.

2. AGRICULTURAL BOTANY

(Monday, 4th April. 1 P. M. to 4 P. M.)

Answer three questions in A and three questions in B. Questions 1 and 8 are compulsory Write answers to sections A and B in separate answer books.

A

1. Give the characteristic features of the *natural orders* to which the following cultivated plants belong :—Ginger, Coriander, Garlic and Cardamom.
2. Illustrate with the help of the pepper plant how external factors influence plant habit and distribution.
3. What are Enzymes? Give a general account of their role in the plant.
4. Write notes on :—(*a*) Epiphytes, (*b*) Symbiosis, (*c*) Saprophytes, and (*d*) Insectivorous plants.

B

5. With the aid of rough sketches describe—(*a*) an onion bulb, (*b*) a potato tuber, (*c*) a siliqua, (*d*) a jack fruit, (*e*) a carrot, (*f*) an apple fruit
6. Fully explain with diagrams the structure, mode of formation, and functions of cork.
7. Contrast the structure and physiological properties of a green leaf and a mature seed.
8. Write an account of respiration and the part it plays in the life of the plant.

3. AGRICULTURAL CHEMISTRY

(Tuesday, 5th April. 7 A. M. to 10 A. M.)

Answer three questions in A and three questions in B. Questions 3 and 5 are compulsory. Write answers to A and B in separate answer books.

A

1. Describe methods of synthesis, and give reactions of ethyl alcohol and glycerol which would go to prove that these substances contain one and three hydroxyl groups respectively.
2. Starting from acetic acid, how would you prepare methyl alcohol and how would you proceed to prepare ethyl alcohol by starting from methyl alcohol? Explain the reactions involved.
3. How can glucose be obtained from cane sugar? From its behaviour on oxidation indicate the class of compounds to which glucose belongs. What is the action on glucose of (*a*) an alkaline solution of copper sulphate, and (*b*) an ammoniacal solution of silver nitrate?
4. How is urea prepared? What is its relation to carbonic acid? How does it decompose in contact with water?

B

5. What is a soil? What is it composed of and how can its defects be remedied?
6. Write short notes on :—(*a*) pore space, (*b*) hygroscopic moisture, (*c*) humus, (*d*) capillary action.
7. What is the nitrogen cycle in the soil? What part do micro-organisms take in the cycle?
8. State how the physical properties of a soil influence its fertility.

4. AGRICULTURAL ZOOLOGY

(Tuesday, 5th April. 1 P M. to 4 P.M.)

Only six questions are to be answered. Question 4 is compulsory.

1. Describe the development of wings in Insecta.
2. Classify Hymenoptera and mark out the economically important families, giving examples of South Indian forms.

3. Describe with the aid of sketches the external sexual organs of insects.

4. The study of the life-histories of insect pests yields clues to their control. Examine how far the statement is true of the chief South Indian crop pests whose life-histories have been studied.

5. Name the more important coleopterous pests in the Madras Presidency and give an account of the methods adopted for their control.

6. A ryot sending a consignment of insect-attacked cotton boll reports that his crop is being badly damaged and seeks relief. In the absence of specimens of pests in the bolls, to what pests or pests would you attribute the attack, and why? What advice would you give him?

7. Discuss the possibilities of the following in insect control in South India, giving instances of trials, if any known to you:—

(*a*) Calcium cyanide dusting. (*b*) Soil fumigation. (*c*) Chemotropic methods.

5. AGRICULTURE I

(Wednesday, 6th April. 7 A. M. to 10 A. M.)

Answer only Three questions in A *and Three questions in* B. *Questions* 4 *and* 7 *are compulsory. Write answers to* A *and* B *in separate answer books.*

A

1. Explain the principles underlying the following farming practices:—
(*a*) mulching dry lands; (*b*) use of roller after sowing; (*c*) baling water by picottah (*d*) growing mixed crops.

2. Explain how rotation of crops helps to maintain soil fertility. What part do rotations play in the farming practices of South India? Indicate improvements in the present system.

3. There is a block of red loamy soil unreclaimed at the foot of the hills near Coimbatore. Estimate the cost of reclamation and suggest a suitable cropping.

4. Explain the principles underlying the feeding of (*a*) a working bullock, (*b*) a cow in calf, (*c*) a heifer 2 years of age. Suggest suitable rations and estimate the cost of maintaining for a year a herd consisting of 5 pairs of working bullocks, 5 dry cows, and 5 weaned heifer calves under 2 years.

B

5. Draw a sketch of an improved plough and name the several parts. Compare the working of this implement with that of the local plough.

6. 'The soil is ever changing.' Explain this statement fully and state in what ways the farmer is concerned with the changes happening in the soil.

7. Compare (*a*) an Ongole and a Kangayam bullock, (*b*) an Ongole cow and an Ayrshire-Scindhi cow.

8. Discuss the ordinary tillage operations with reference to the moisture content of soils.

AGRICULTURE II (Including Animal Hygiene)

(Wednesday, 6th April. 1 P. M. to 4 P. M.)

Only six questions are to be answered. Questions 4 and 5 are compulsory.

1. Explain the mechanism of respiration in the ox.

2. Describe the kidney of the ox. Explain how urine is excreted. What is its composition?

3. What is Black Quarter? How is it caused? What animals are susceptible to it? Describe its symptoms and the means you would adopt in dealing with an outbreak of the disease in a farm.

4. Describe how you would treat the following:—(*a*) hoven, (*b*) retention of placenta, (*c*) broken horn.

5. Explain the different methods of castration you know of and the respective advantages and disadvantages if (any) of each of the methods.

6. Give the actions, uses, and doses of the following drugs in cattle:—(*a*) asafoetida, (*b*) camphor, (*c*) chiratta, (*d*) catechu.

7. Name any *two* common contagious diseases among poultry you have observed. Describe any *one* of them as regards its aetiology, mode of infection, symptoms, and treatment.

PART II

1. AGRICULTURAL BOTANY I

(Monday, 11th April. 7 A. M. to 10 A. M.)

Only five questions are to be answered.

1. Give a botanical description of the various parts of the Italian Millet (*Setaria italica*), specifying the variations noticeable in the floral parts.

2. Describe the directions in which you will attempt to improve the three Solanaceous crops, Tobacco, Chilli, and Potato.

3. What are fibres? Classify the fibre yielding plants of the Madras Presidency into their respective natural orders and indicate the morphology of the fibre in them.

4. Describe the inflorescence and mode of pollination in Palmyra, Castor, and Cambu.

5. Explain clearly, choosing *three* typical local weeds, how their botanical equipment enables them to persist in arable land.

6. What is alternation of generations? Compare this phenomenon in Bryophytes with that in Angiosperms.

7. Give an account of the life-history of Spirogyra with illustrations.

2. AGRICULTURAL BOTANY II

(Monday, 11th April. 1 P. M. to 4 P. M.)

Only five questions are to be answered.

1. Write an account illustrated by diagrammatic drawings of *any two* of the following:—(*a*) the development of a bulbous root, (*b*) the development of an albuminous seed, (*c*) the growth in length of the stem of a cereal.

2. 'Vegetatively the plant multiplies but remains the same; through sex it changes.' Discuss the statement from the point of view of the plant breeder.

3. How is Callus formed? What advantage is taken of this in horticultural practice?

4. What are Chromosomes? Give a critical account of the Chromosome theory of heredity.

5. Explain what is meant by translocation and how it is effected What part does it play in the life-histories of annuals, biennials, and perennials?

6. Give an account of *any two* of the following;—
(*a*) grape mildew, (*b*) red-rot in sugar-cane, (*c*) stem bleeding disease in palms.

7. Give examples of diseases which are seed borne. State by reference to specific examples how the diseases may best be combated.

3. AGRICULTURAL CHEMISTRY I

(Tuesday, 12th April. 7 A. M. to 10 A. M).

Only five questions are to be answered.

1. What is an 'albuminoid ratio'? What is its importance in fixing rations for cattle? What is the effect of wide ratio and narrow ratio foods on calves?

2. How is the digestibility coefficient of a food-stuff determined? What is approximately the digestibility coefficient of the food constituents in hay and in oil-cakes?

3. You are asked to give your opinion on a sample of wheat bran as cattle food. How would you examine it? What determinations would you do and how would you interpret the results obtained?

4. What is the average composition of buffalo milk? It is found that a particular sample contains 13 per cent. total solids and 3·5 per cent. fat. Discuss fully how you would come to any conclusion with regard to the material and its proportion used in adulterating the milk.

5. What is meant by 'ripening of cream'? Explain the changes which take place during the ripening. In what way do these changes help in the preparation of butter?

6. In what way does milk fat differ from other fats? How would you proceed to examine a sample of butter to find out whether it is pure? How would you interpret the results of your determinations?

4. AGRICULTURAL CHEMISTRY II

Tuesday, 12th April 1 P.M. to 4. P.M.

Only five questions are to be answered.

1. Write brief notes on :— *a* nutritive value, *b* maintenance requirements, *c* amino acids, *d* crude fibre, and *e* vitamins.

2. What experimental precautions would you take in conducting a nitrogen metabolism experiment? What is the significance of a *negative* nitrogen balance?

3. What are Proteins? State concisely the steps you would take to estimate the nitrogen in a sample of cholum grain.

4. You are given the chemical analysis of the soils from two closely contiguous plots *A* and *B* as below. Plot *A* is reported to grow good crops, and on *B* the crops to be very poor. What manurial treatment would you suggest to improve the fertility of *B*? State reasons for your answer.

Chemical analysis of the two soils.

	Plot A	**Plot B**
Organic matter	5·62 per cent.	5·70 per cent.
Calcium oxide	1·10 ,, ,,	0·32 ,, ,,
Phosphoric acid	0·07 ,, ,,	0·03 ,, ,,
Potash	0·72 ,, ,,	0·65 ,, ,,
Nitrogen	0·03 ,, ,,	0·04 ,, ,,
Ph. value	5·59 ,, ,,	4·90 ,, ,,

5. State what you know about the biochemical changes produced in a green cereal crop when pitted for conversion into silage.

Is the Tower or Pit silo better suited for Indian conditions? Why?

6. Describe how you would convert prickly pear into a substitute for cattle manure. How would the resulting material differ from average cattle manure?